VersaNet2
Radio Data Network

User Manual

Radio Data Technology Limited

England

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10-11 Taber Place, Crittall Road, Witham, Essex, CM8 3YP, England
Telephone +44 (0) 1376 501255 Telefax +44 (0) 1376 501312
email: sales@radiodata.co.uk web: www.radiodata.co.uk

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Section 1 General Information

1.1 Introduction

VersaNet2 is a secure radio data network used for a variety of data transfer applications, including process monitoring and control. The use of radio for such tasks can permit a more cost-effective and flexible solution than offered by cabled methods.

VersaNet2 accepts signals from all types of standard industrial transducers (analogue, digital or pulse count). It then sends these signals, usually by uhf radio, to one or more remote receiving points where they may be output in their original form, or to a computer based SCADA system.

Every unit (Node) contains a highly intelligent, fully programmable, communications controller, which coupled with the units modular structure, offers true flexibility. The intelligent controller ensures efficient and secure transmission with features such as, Listen Before Transmit – which saves wasted transmissions on shared bands; Multiple Error Checks – ensuring data integrity at every stage; a proprietary Radio Protocol – employing message acknowledgements and automatic retries, improving transmission security. There are many other features, which are covered in the relevant sections of this manual.

Powerful repeater functions mean VersaNet2 can reach difficult locations not possible with other point to point systems. Every VersaNet2 Node can act as a repeater – even a low power Node and there is virtually no limit to the number of repeater steps in a chain. (There are some overall system size limitations discussed later).

For locations outside of the range of the uhf radio, VersaNet2 has the capability of using standard wire line modems or GSM. Using this facility, there is virtually no limit to the coverage area of the system. Each Node can be configured to work with either a uhf radio, a GSM modem or both. This is particularly useful to enable GSM to be used as a back-up (secondary route) in case of failure of the radio link. Using a GSM modem, SMS messages can also be sent for example, to an engineer to advise of a problem.

All VersaNet2 nodes are constructed and configured from standard modules to handle various data Input/Output (I/O) combinations, including analogue, digital and pulse signals. A serial data highway is also available for direct connection to PC's and equipment used within SCADA systems. Where appropriate, a Node may also be configured as a Low-Power Node utilising the battery economizer system

By operating in the low-power Industrial, Scientific and Medical (ISM) bands, VersaNet2 may be used in some countries without the need for a license (UK MPT1329), or on licensed frequencies, where no license free allocation exists. VersaNet2 meets the European R&TTE Directive 1999/5/EC and most worldwide radio standards for both radio performance and EMC regulations such as ETS 300 220, ETS 300 113 and ETS 300 683.

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1.2 How to use this Manual

Section 1 - General Information

This section should be studied by all users as it gives a good introduction to the system and contains important safety and warranty information to be followed when using a VersaNet2 System.

Section 2 – System Description

In this section you will find details of how the VersaNet2 system operates, including a description of the data handling, I/O addressing and message construction. There is also a brief overview of the VersaNet2 software modules and how to load and run them.

Section 3 – Designing and Building a System

This section covers the steps required to successfully plan a reliable and efficient VersaNet2 Radio Data Network. It helps the reader understand how VersaNet2 operates and how all the component parts interact. It also covers selection of the correct I/O Modules, Power Supplies, Enclosures and Antennas. The section finishes with a brief overview of programming a Node, which is described in detail in section 4.

Section 4 – Versanet Manager (VNMGR)

This section begins with the configuration of the Node hardware and how to programme the parameters into the Node. There is then a detailed explanation of all the features programmable through the Node Manager software.

Section 5 - Installation

This section should be followed when constructing, installing and configuring a VersaNet2 system. It takes the reader through logical steps enabling VersaNet2 to be operated successfully with minimum effort. The section assumes the desired system has been properly planned, an I/O scheme drawn-up and the necessary modules and accessories have been procured.

Section 6 - Commissioning

This section covers the setting up and testing of a VersaNet2 system on site, once the hardware has been installed. It mainly deals with the radio communications, selecting RF channels and checking signal strength.

Section 7 – Technical Specifications

There is a general introduction followed by a detailed specification for each module. Details include mechanical dimensions, circuit block diagram and connection chart.

Section 8 – Accessories

This section includes details of a full rang of accessories to support VersaNet2, including, enclosures, antennas, power supplies and modems.

Section 9 – Appendices

Details of the various external interfaces including Modbus are given in this section.

1.3 Safety and Limitations of Use

VersaNet2 has been designed to the highest standards to enable it to be used in a wide range of demanding applications. It is not, however, infallible and should always be complemented by fail-safe mechanisms in the overall system in which it operates. VersaNet2 is not authorised for use in life-support or airborne civil defence applications without express written approval from RDT.

1.3.1 Electrical Safety

The equipment has been manufactured and tested according to ISO9000 guidelines and has been supplied in a safe condition. When operated from mains power supplies, the equipment should be properly earthed. It is important that the following precautions are followed to ensure safe operations:

1.3.2 Physical Damage

If the equipment appears or is suspected of having suffered physical damage due to extremes of transit or storage it should not be connected to an electrical supply unless comprehensively checked by an authorised representative of the supplier.

1.3.3 Access to Circuitry

The nature of the product means that live parts may be exposed when the enclosure lid is removed or if an open mounting arrangement has been used. For this reason, only qualified personnel aware of the potential hazard should be permitted access to operational equipment for configuration or maintenance purposes. If it is necessary to add or remove modules, the power supply should be completely isolated beforehand. Note that capacitors on the power supply module may still be charged after the supply has been disconnected.

VersaNet2 makes use of electronic solid state devices, many of which are static sensitive. Should there be a need to handle the modules, care should be taken to ensure only the edges are touched and standard precautions for static sensitive devices should be followed.

1.3.4 Fuses

Fuses are fitted to all power supply modules and should be replaced with new fuses of the equivalent type, if failure occurs. The use of repaired fuses or short circuiting fuse holders should be strictly avoided and this will also invalidate the warranty.

1.3.5 Mechanical Safety

In order to construct a VersaNet2 node, the Basic Enclosure may need to have polycarbonate panels removed to take cables or accessories. This involves the use of some force and may result in small particles of polycarbonate being a potential hazard to unprotected eyes. For this reason, it is strongly suggested that in addition to observing good workshop practice, eye protection is used throughout the node construction process.

1.4 Warranty

1.4.1 Guarantee

a. The Seller guarantees at its discretion to refund the price of the goods or to repair or replace free of charge any of the goods found to its satisfaction to be defective within 12 months of the date of delivery owing to faulty design, materials or workmanship, provided that the goods have not been modified or repaired other than by the Seller and have been operated, stored and maintained within the Seller's recommendations for use.

b. Goods returned under this guarantee shall be delivered to the Seller's premises at the Purchaser's expense.

c. The Seller's obligation herein to refund repair or replace the goods is the sole liability of the Seller as regards the quality fitness or description of the goods and their correspondence with sample. All other representations warranties conditions terms and statements as regards the same express or implied, statutory or otherwise are excluded save where not capable of exclusion at law. The Seller is under no further liability in contract tort or otherwise for any loss damage or injury arising directly or indirectly from or in relations to the quality fitness or description of the goods and their correspondence with samples.

d. The Purchaser shall inspect the goods and notify the Seller of any defects or other non conformance within 30 days from the date of delivery.

1.4.2 Limitations of Use

Suppliers products are not authorised for use in devices or systems for life support applications or airborne civil aviation applications without the express written approval of RDT. RDT does not assume any responsibility for the use of the products described. No product patents are implied and RDT reserves the right to change the said products without notice at any time.

Section 2 System Description

2.1 How VersaNet2 Operates

2.1.1 Nodes & Networks

VersaNet2 modules are connected together to form nodes. Each node is configured to handle its Input and Outputs (I/O) and communicate with other nodes. The way in which different nodes communicate depends upon the functionality required and the available radio paths.

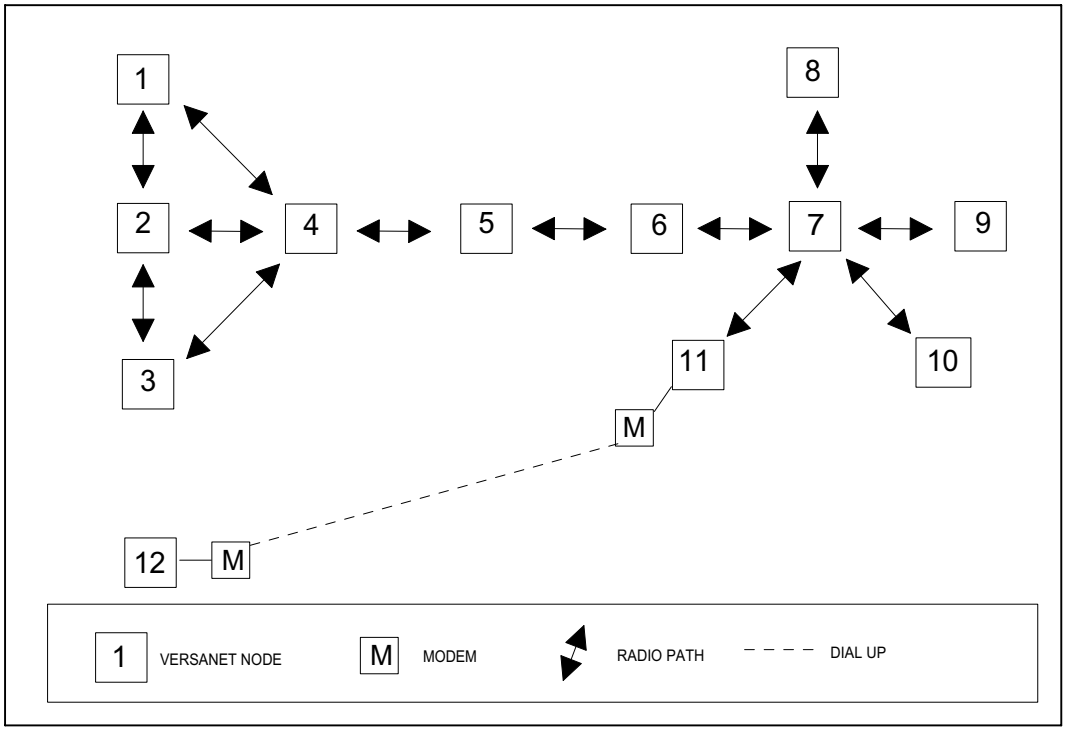


Figure 1 Example VersaNet2 System

The diagram shows an example VersaNet2 network. All nodes have a Communication Controller containing the radio and node intelligence, as well as storing the node configuration in non-volatile memory. Every VersaNet2 Node has the same capability so they communicate using a 'peer-to-peer' architecture rather than 'master-slave'.

The main function of Nodes is to send and receive I/O. They operate on a single radio channel and may be used to form a simple point-to-point system or a network of nodes with each Node being capable of communicating with any other Node within radio range. Any Node can function as a 'repeater' or 'relay' which extends the effective system range and/or permits the circumnavigation of obstacles.

In the above example, Node 12, which is outside of the normal radio coverage, is fitted with a GSM modem for a dialup connection. This Node can send information to any other Node in the system via Node 5, which also has a GSM modem. In addition, any Node fitted with a GSM modem can send SMS messages.

A Node can be fitted with either a uhf radio, a GSM modem, or both, as in the case

of Node 11 in the above diagram. Note that a Wire Line modem can also be used in place of the GSM. See Section 8 for details of the GSM and Wire Line Modems supported.

All Nodes within the same system must have a unique Node Number and the same Network Name.

2.1.2 Communications

A Network is formed by a number of Nodes, with the simplest being a two Node chain.

Nodes operate entirely on a single configured RF channel. When no data is being exchanged, the receiver is switched to the RF channel and waits for an instruction. For example, in a three node network, if node 1 needs to send data to node 2, it first listens to the RF channel to check it is not in use (Listen before Transmit) and then sends a message to node 2. Node 2 acts on the message and sends an acknowledgement back to Node 1.

If Node 3 also wanted to send data to Node 2 at the same time it would have encountered activity on the RF channel and thus would have waited until it was clear. Care should, therefore, be taken to ensure your system can handle potential delays that may occur when channel activity is high.

Every transmission from one Node to another is acknowledged. If a transmission is unsuccessful then the Node will re-try up to a maximum number of 9 times. The number of re-tries is configurable between 0 and 9.
If after the programmed number of retries, communication is still unsuccessful and no acknowledgement is received, a 'comms-fail' alarm is activated. It is strongly recommended that this alarm is programmed to activate only after at least 2 TX intervals i.e. 2 attempts to send the data. This is because there are a number of reasons why occasionally radio communications may fail, interference, weather conditions etc. Setting the alarm delay to twice the transmission interval reduces false alarms. See section 4.4, programming.

Data to be sent from one Node, (e.g. Node 1), to another Node, (e.g. Node 6), is programmed in a connection list. A 'Primary Route' is also programmed. This gives information such as send data via Node 2, where Node 2 acts as a repeater. It is also possible to programme a 'Secondary Route'. If the primary route fails or is unavailable for any reason the system automatically defaults to the secondary route. This route may go via Node 3, where Node 3 is the repeater. The secondary route may also be a wire-line or GSM Modem.

2.2 Data Handling

The previous pages explained how VersaNet2 operates as a communications system. This section explains what types of data VersaNet2 can handle and how it uses this communications system to send securely coded data over sometimes complex paths.

The explanation breaks down into the following components:

2.2.1 Input and Output Types

Data gets into and out of a VersaNet2 Node via I/O modules, or the I/O on the Communications Controller module. These I/O modules are connected to the Communication Controller via T2-BUS interconnections to form a complete Node. The modules listed in the table below are the "prime" I/O modules and up to sixteen

of each may be used in a single Node. (Note: to a maximum of 128 inputs and outputs per Node).

Module Name	No of Inputs/Outputs
IRDN202 Digital/Pulse Input	8 Inputs per Module
IRDN201 Digital Output	8 Outputs per Module
IRDN207 Analogue Input	8 Inputs per Module
IRDN208 Analogue Output	4 Outputs per Module
IRDN209 Pulse Output	8 Outputs per Module
IRDN212 Low Power Pulse Input	8 Inputs per Module
IRDN214 Alarm Output	8 Alarm Outputs per Module

Table 1 – Prime I/O Modules

Note that each channel on the IRDN202 module is software configurable to accept either Pulse Counting Inputs or Digital Inputs (volt-free contacts).
All these modules must be used in conjunction with a suitable power supply.

The next table lists the three modules having a mixture of I/O types.

Module Name/Code	I/O Configuration
IRDN203 Combination Input	4 Digital Input + 4 Analogue Input + Mains PSU
IRDN210 Combination Output	4 Digital Output + 2 Analogue Output
IRDN211 Low Power Input	4 Digital Input + 4 Analogue Input + DC Connection

Table 2 – Mixed I/O Modules

Only one of each of the modules in the above table can be used in a Node since they each have a fixed address. See Section 2.2.2b below.

The final module capable of handling I/O directly is the Communication Controller. It has the following data ports:

Communications Controller Data Ports
1 Digital Input, 1 Digital Output 1 Analogue Input, 1 Analogue Output 1 Pulse Counting Input, 1 Pulse Output 1 Alarm Output 1 Serial Data Highway 1 Configuration/Monitoring Port

Table 3 – I/O Capability of Controller Module

2.2.2 Addressing

All data inputs and outputs are allocated a unique address enabling data to be transferred anywhere within a system. Addressing breaks down into two areas:

a. Node Address

Every Node has a unique address, constructed as follows:

[NETWORK NAME] [NODE NUMBER]

For example, Node 3 in network ABC has a Node address of ABC3.

b. Data Address

Each data point is allocated a data address, constructed as follows:

[I/O TYPE] [MODULE NUMBER] [CHANNEL NUMBER]

[I/O TYPE]	A Analogue D Digital P Pulse
[MODULE NUMBER]	0 Communications Controller 1-16 "Prime" I/O Modules 17-29 Virtual Memory 30 Combination Output 31 Combination Input 32 Low Power Input 33-256 Virtual Memory
[CHANNEL NUMBER]	1-N Where 'N' is the total number of that I/O type on a module

Table 4 – Data Address Definition

For example, an Analogue Input Module on a card that has been set to Card Address 1, will have the following valid data addresses, corresponding to the eight input channels:

A1.1, A1.2,……. to A1.8

If a second Analogue Input Module is added to the same Node and set to Card Address 2, the additional addresses available are:

A2.1 to A2.8

A Combination module always takes a unique Module Number of 30 (Output), 31 (Input) and 32 (Low Power Input). The Communication Controller is always Module Number 0.

Note that it is possible to have an input and an output with the same data address and Node address. For example, a Node fitted with analogue inputs and outputs will have the following valid data address:

Inputs A1.1 to A1.8
Outputs A1.1 to A1.4

VersaNet2 will interpret the addresses correctly based on their position in the message packet, as described in the next section.

c. Virtual Memory (Virtual Address)

From table 4 it can be seen that addresses (channel numbers) from 0 to 16 are normally used for hardware I/O modules. These addresses are set by DIL Switches on the modules. It is possible however to use addresses 17 - 29 and 33 - 256 as

Virtual Memory locations (or Virtual Outputs). Note that if no hardware is fitted, addresses 1 – 16 may also be used as virtual outputs.

When a Node receives data for a Virtual Output, there is no hardware (output module) associated with this address. Instead, the Node stores the data in memory, which can be accessed by the SCADA. This data can also be accessed through VNMGR using the Monitor facility

2.2.3 Message Address Construction

The Node Number and Data Addresses are used to configure VersaNet2 by constructing messages defining what data is sent to where. Only Nodes with the same Network Name will communicate with each other. The message packet construction is as follows:

SOURCE	DESTINATION	ROUTE
Node Number: Data Address	Node Number: Data Address	Node Number

In normal use, this message is entered in parts by responding to questions during configuration. For example, Data Input A1.3 on Node number 1 is to be sent via Node 2 to Node 4 and output on Data Output A1.4

The SOURCE and DESTINATION parts of the message are entered into the 'Connections' screen within the VersaNet2 Node Manager Software (VNMGR). The ROUTE is entered into the 'Routing' screen.

SOURCE	DESTINATION	ROUTE
A1.3	4A1.4	2

NOTE: It is not necessary to enter the Node number (as part of the address) in the source, since this is the Node being programmed.

Data inputs may be sent to more than one output by simply entering additional connections and routes. Similarly, more than one input may be sent to a single output, but care should be taken to avoid unexpected results. Pulses, for example, must only have a single input sent to a final destination, otherwise the pulse count will be incorrect.

2.2.4. Over the Air Protocol.

VersaNet2 uses a proprietary ‘over-air’ protocol to ensure secure sending and receiving of data messages. A brief description of the message structure is as follows:

A message is transmitted as a series of fixed length packets, each 23 bytes long. A message will contain a string of these packets in the sequence, preamble, header, data. The number of data packets depends on the amount of data in the message. Each packet takes approximately 75mS to transmit.

Every packet in a message contains synchronization bits, the number of packets in

the message, network name, originating Node and destination Node. Each packet ends with a checksum, which allows for error checking of each packet at the receiving Node. The Header packet contains additional information including message number and routing details. The data packet has 7 bytes reserved for the message content. Longer messages are split over a number of packets.

If the message is received and decoded correctly with no errors, the receiving Node sends back an acknowledgement of a single packet.

A full description of the over-air protocol is available from RDT if required.

2.3 Software

There are 3 software modules associated with VersaNet2:

Node Software	filename: NODE2-XX.A20	Approx size: 325Kb
Flash Download	file name: VNFUD2-XX.EXE	Approx size: 600Kb
VersaNet Manager	file name: VNMGR2-XX.EXE	Approx size: 760Kb

These are all supplied on CD and must be loaded into your own PC. See below for details of loading software. (Note: floppy disk versions are available on request) The PC should be running Windows 95 or later (including NT and XP)

Note: Software version control is by the two digits shown in the above file names as XX. For example NODE2.01, NODE2.02 etc. To check the version of software running on a Node use VersaNet Manager, 'Test' facility. See Section 4.4.12 The version of VersaNet Manager in use is displayed in the title bar at the top of the open window.

Node Software

This programme is written in 'C' and then compiled down to machine code. The programme is loaded into the flash memory of the on-board microprocessor for each Node.

Note: VersaNet2 Nodes are shipped from the factory with the Node software pre-loaded. Normally therefore, it should not be necessary for customers to load Node software. If you need to load software, to update to a new version, follow the instructions later in this section.

Flash Download

This programme, written in Delphi, is required to download the Node software into the flash memory of the processor. If you need to update your Node software, follow the instructions later in this section.

VersaNet Manager.

The VersaNet Manager programme is the main customer interface to a VersaNet2 Node. It allows programming of all customer selectable parameters, data I/O connections, routing etc. and has powerful monitoring and test facilities. All the features of VersaNet Manager are described fully in section 4.

The CD Contents

As well as the three major software modules above, the CD has a complete copy of the VersaNet2 Manual and other useful information. See the leaflet supplied with the CD for more information.

Running the CD

Place the CD in the drive. Using Windows Explorer, copy or drag the files to a convenient folder. (It is advisable to first create a VersaNet2 folder and keep all information together in this folder). If required, create a shortcut for VNMGR and send to the desktop.

Downloading Node Software

Connect the Node, configuration port JP7, to your PC with an RS232 cable (see section 9.3) and power up the Node. Wait for the Node to initialize (Red power LED 'on', Orange RX LED 'on' and Green run LED 'on' and steady).

Open VNFUD.
Check that the correct COM port is selected in the box at the top of the screen.
Using the Browse facility, select the version of NODE software to be downloaded. Click on it in the VersaNet folder and 'open'. It will then appear in the Object File field.

Check that 'LINK 1' on the controller card is set to 'RUN' position and Click 'Start Transfer'.

The first status bar will indicate the progress of the Flash Upload. Once the initial upload is completed, you will be prompted to move 'LINK 1' to the 'PGM' (programme) position. The software will then continue with the downloading. The status bars indicate the progress.

When the download is completed, you will be prompted to move the 'LINK 1' back to the 'RUN' position. Wait a short time and you will be prompted that the download was successful and the new version number will be displayed.

The whole process takes a few minutes.

If you encounter any problem downloading, try aborting the download and checking the 'Use Low Speed' box on the initial screen. This will run the whole process slower, which may be required for some older machines, especially notebooks.

Section 3 Designing and Building a System

3.1 System Planning

Planning a VersaNet2 Radio Data System requires some knowledge of the product's capabilities and how the component parts interact. This section of the manual begins with a planning overview and continues with all the technical and practical information required to plan an efficient and reliable radio data system.

3.1.1 OVERVIEW

a. **Establish Node Locations and Communication Functions**

The first major step in system planning is to establish the location of each Node and decide on the method of communication, normally uhf radio. Section 3.2 describes this operation in more detail.

b. Establish I/O scheme

The entry and exit points in the system for all data, including the type etc, should be carefully planned. This enables the correct I/O modules to be selected, destinations for each message and the update period for each communication to be established. Refer to Section 3.3 for more information.

c. Establish Power Supply Requirements

Having selected the I/O modules, the overall current consumption can be calculated and the necessary power supply modules selected. Refer to Section 3.4 for power consumption of modules and power supply options.

d. Select Enclosures and Accessories

The number, type and size of enclosure space required for each Node should be calculated. Additional enclosures and fixings can be selected if required. Refer to Section 3.5 for Enclosure sizes.

e. Select Antennas and Fittings

Refer to Section 3.6 for Antennas and cable. Select the correct antenna for the application based on location and required coverage distance.

3.2 Node Location and Communication Functions.

The best approach to planning a system is to start by drawing the proposed network on paper, or better still on a map of the area. Check that distances between sites are within radio coverage range and that there are no large obstructions blocking the line of sight between Nodes. Refer to Section 3.6 for guidance on antenna selection and coverage range. Remember that raising the height of the antenna clear of all obstructions will significantly increase coverage range and improve reception.

Accurate planning will almost certainly require visits to sites. Care should also be taken on locating the equipment. This should be positioned, wherever possible, in a sheltered location with easy access for installation and ongoing maintenance.

Distances between the radio and antenna should be kept to a minimum for optimum performance.

In addition to uhf radio, VersaNet2 provides for connection using wire line modems or GSM. If any of the proposed sites are outside of the normal radio coverage area, one of these options could be considered. If GSM is an option, check with the local carrier on coverage for the proposed sites.

During the planning stage, consideration should be given to Secondary Routing. VersaNet2 can be programmed to automatically select an alternative route if the Primary Route (first choice) fails for any reason. This is a very powerful feature giving added system integrity and it can make use of wire line or GSM modems for the secondary route as an alternative to radio, or where a second radio path is not possible.

3.3 I/O Scheme

Refer to Section 2.2 for details of available I/O.
As part of the planning process, the input and output requirements for each Node must be decided. This will enable selection of the correct I/O modules and in turn, the correct power supply and housing.

It is a good idea at this stage to produce a connection list for each Node detailing the inputs and their corresponding outputs on other Nodes. This information will be required when programming the Node. In addition, from the network drawing, decide on any requirement for secondary routing and possible use of GSM or Wire Line modems. All of this information will ensure correct selection of hardware and make it easy to programme the Node prior to installation.

3.3.1. Routing

Data can be sent from any Node in the network to an output on any other Node in the network. To enable this facility, information about the route the message takes through the network must be programmed into the relevant Nodes. Refer to the network example shown in figure 1, section 2.1.1.

Each Node in the network can communicate with an adjacent Node directly without repeaters and therefore requires no entry in the routing table for these straight point to point connections. In the example Node 7 can communicate directly with Nodes 6, 8, 9, 10 and 11.

To send a message from Node 2 to Node 7 however requires Nodes 4, 5 and 6 to be used as repeaters. These Nodes must be programmed with routing information. Node 2 must be told to go via Node 4. Node 4 must be told to go via Node 5 and likewise Node 5 is told to go via Node 6. Note that Node 6 needs no routing since Node 7 is adjacent.

Note. There is no need to programme reverse paths for acknowledgements. These are learnt from the outward message.

3.3.4. Secondary Routing

A Secondary route may be programmed, which will be automatically selected if for any reason the Primary route fails, or is unavailable. In figure 1 assume Node 1 is programmed to send to Node 3 via Node 2. Node 1 would have the routing information programmed as in 3.3.1 above. A Secondary route could be programmed to go via Node 4 in the event of a problem with the Primary route.

Node 1 may be programmed to send a digital input D0.1 to a digital output 3D0.1. It is programmed for 3 retries. If after 3 retries the communication is unsuccessful, there has been no response from Node 2, it will automatically default to the secondary route and make the connection via Node 4. At the next transmission it will revert to the Primary route again and repeat the process if the problem still persists. Note that the 'comms-fail' alarm will be activated by the failure of the Primary route. There is no alarm on the secondary route.

3.4 Power Supply Requirements

There are a number of options for powering a VersaNet2 Node. It may be powered directly from a DC supply or from an optional mains supply. There is also the possibility to configure the mains supply for battery back-up. The total power requirement for the Node must be calculated (see table 5 below – use Max values) and the correct power supply selected.

A small Node can be constructed using an IRDN203 Combination Card and a Communications Controller Card. The IRDN203 has a built in mains supply that can run both itself and the Controller. The Power Supply does not have enough capacity to run any further cards.

A further option is to construct a Low Power Node. This is particularly useful for remote locations with no mains power availability. The Node can be powered by batteries running from Solar Cells or Wind Generator. There are 2 cards especially designed for this purpose, the IRDN211 and IRDN212.

Current consumption of cards

Card type	Description	Typ current	Max current
IRDN200	Communications Controller	380mA - RX	650mA - TX
IRDN201	8ch Digital Output	130mA	250mA
IRDN202	8ch Digital or Pulse Input	50mA	70mA
IRDN207	8ch Analogue Input	50mA	100mA
IRDN208	4ch Analogue Output	50mA	120mA
IRDN209	8ch Pulse Output	50mA	75mA
IRDN210	Combination – 4 Digital + 2 Analogue Output	50mA	120mA
IRDN211	Low Power Input, 4 Digital + 4 Analogue	*50mA	100mA
IRDN212	Low Power Input, 8 Pulse	5mA	5mA
WMOD2B	GSM Modem (Wavecom)	130mA	700mA - TX
TD-32	Wire Line Modem (Westermo)		

Table 5 Module Current Consumption

* Only 400µA in sleep mode (see section 3.4.8)

3.4.1 DC Power Supply

A 12v DC power supply can be connected to the Communications Controller Card through connector JP13. This supply is then distributed via the T2-BUS to all the other cards in the Node. Use the table above to calculate the maximum current required for the particular Node configuration. Note that the maximum input current at JP13 is 3 Amps. A second supply can be added if required using a DC Adaptor card IRDN206.

3.4.2 Mains Power Supplies

An integral mains power supply can be fitted in the Node, with the DC output connected to JP13 of the controller card for distribution to other cards, as above. Calculate the total current consumption of the Node from the above table, then select the appropriate power supply as follows:-

PSU 1291	90 - 264vAC - 12v output @ **1.0 A**	Nominal Size 90L x 51W x 22H
PSU 1292	90 - 264vAC - 12v output @ **2.0 A**	Nominal Size 102L x 51W x 32H
PSU 1293	90 - 264vAC - 12v output @ **3.0 A**	Nominal Size 102L x 51W x 32H

Notes
Two or more power supplies may be fitted for larger Nodes, where required. To connect a second power supply a DC Adaptor Unit, IRDN206, will be required to connect the supply directly to the T2-BUS.

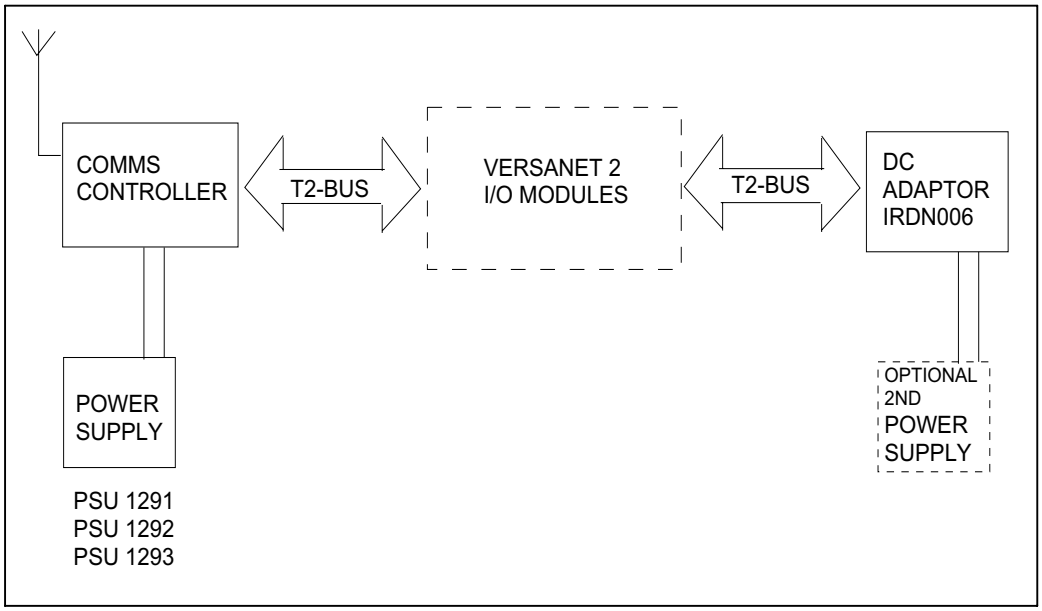


Figure 2 Module arrangement for Mains Powered Option

3.4.3 Battery Back-up

There are a number of factors to be considered when using battery back-up. For this type of application, where the battery will be continuously trickle charged, it is recommended to use a sealed lead acid battery.
If the battery becomes discharged, during a power failure for example, it will initially draw a high current from the power supply, when the mains supply returns. This means the power supply must be capable of handling the current requirement for the Node, plus this initial (inrush) demand from the battery. To select a Power Supply with the correct rating therefore, you need to calculate the current for the Node and add the battery inrush current.

First, you must calculate the capacity of the battery required.
From table 5 above add up the total power requirement for the Node using the **typical** figure. (This assumes a reasonable duty cycle where the Node will not be

taking full power most of the time. If the Node is exceptionally busy and has a high duty cycle, use the 'max' current figures)
Decide on the length of back-up required.
The length of back-up in hours, multiplied by the total current (in Amps) for the Node will give the size of battery in Ah.
Example:
Total current (typ) for Node = 560mA = 0.56A
Back up time 4 hours
4 hours x 0.56A = 2.2 Ah minimum.
or
Total current (max) for Node = 1,000mA = 1.00A
Back up time 4 hours
4 hours x 1.00A = 4Ah

It is not recommended to discharge the battery below about 50% therefore for the above example a battery of about 4 Ah and 8Ah respectively, should be used.

Now calculate the capacity of the Power Supply/Charger.
This is the total of the Node requirement using the **max** figures from table 5 plus the inrush current for a 4 Ah or 8Ah battery.
Battery specifications vary for different makes but as a guide the following apply:-
4 Ah battery Inrush current 1A
8Ah battery Inrush current 2A
16 Ah battery Inrush current 4A

Node max current 1A plus inrush current 1A requires a 2Amp Power Supply
Node max current 1A plus inrush current 2A requires a 3Amp Power Supply

In both the above cases the battery will take approximately 6 to 8 hours to recharge when flattened about 50%.
From completely flat it will take 20 to 24 hours but it is strongly advised not to let batteries discharge below the 50% level.

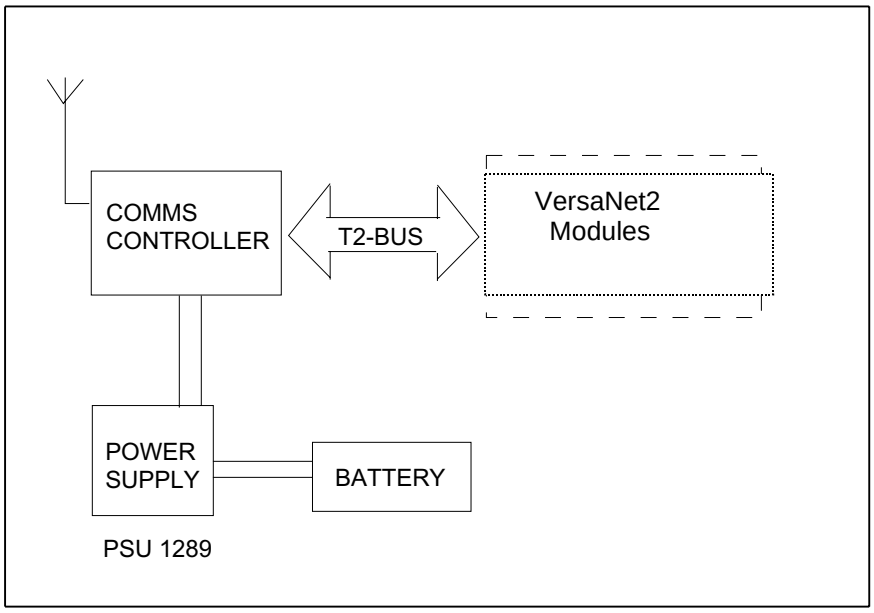


Figure 3 Module arrangement for Battery Back-up

The following Power Supply/Battery Charger is recommended for the above applications:

PSU 1289 240vAC 12vDC output @ 3 Amp Size 171L x 89W x 70 H

3.4.4 ENC 005 Battery Mounting Kit

The Battery Mounting Kit, ENC/005, is used in conjunction with the Basic Enclosure, ENC/001, to facilitate connection of a battery to a VersaNet2 Node. The kit comprises a cable to go from the VersaNet2 module to the battery and a metal base plate incorporating battery retainers for standard 3 A/hr lead acid batteries.

3.4.5 IRDN 203 Combination Input Module

This module is used to provide an on board AC mains power supply and some data inputs, thus forming a small Node. The power supply is only capable of running this card plus the Communications Controller. This option provides a Node with the standard Digital, Analogue and Pulse I/O of the Controller, plus 4 Digital and 4 Analogue Inputs on the IRDN203 Card.

3.4.6 IRDN 211 Low Power Input Module

This module can be used with a Communications Controller (IRDN200) operating in Low Power mode. Such a Node is configured to enter a sleep mode during which period the current consumption is less than 400 µA. The possible Low Power modes of operation are explained in more detail in section 3.4.8
Alternatively, this module may be used in a standard permanently powered system as a cost effective means of combining 4 x Digital & 4 x Analogue Inputs.

3.4.7 IRDN 212 Low Power Pulse Input Module

This module can be used with a Communications Controller (IRDN200) operating in Low Power mode. Such a Node is configured to enter a sleep mode during which period the current consumption is 5mA. Whilst in sleep mode, the Node continually counts pulses, transmitting the totalised count each time the Node wakes up. The possible Low Power modes of operation are explained in more detail in section 3.4.8
Up to sixteen of these modules may also be used in a standard permanently powered system.

3.4.8 Low Power Modes of Operation

For applications where Nodes are located at sites without suitable external power supply, a Node may be configured to operate from a DC supply such as a battery, with the Node switching into a low current sleep mode in between operations, to conserve battery life. It is possible to connect a DC system comprising a battery and solar panel / wind generator to replace current consumed over time, thus eliminating the need to visit remote sites to replace discharged batteries.

The Communications Controller module (IRDN/200), can be programmed to operate as a Low Power Node making use of its on board I/O. If additional I/O is required then only the Low Power Input modules (IRDN/211 & IRDN/212) may be used. Attempting to use any other VersaNet2 module in this mode may cause damage to the module and invalidate the warranty.

Normally a Low Power Node would be at the remote end of a link, used to gather information and transmit back to a central Node. Additional inputs can be added with the 211 and 212 modules. If however the Low Power Node is used at the receiving end, only the single inputs on the Controller Card are available.

A Low Power Node can be used as a repeater to extend coverage distance. In this case it must be programmed as a Low Power Receiver so that it will wake up and receive the signal for onward transmission.

The following section shows examples of Low Power Node configurations:

a. Low Power Transmitter (Send & Sleep Mode)

In this mode, the Node switches on at the end of the sleep period or when the Digital Input (D0.1) on the Communications Controller changes state. The function of the Alarm relay is changed so that it is activated when the Node switches on and can be used as a means of switching power to an external device, via a DC Adaptor Module, IRDN 206.

If the 'Pre Transmit On-Time' is programmed then the Alarm Relay will activate earlier, to allow time for the external device to become fully operational and a reliable reading to be taken prior to transmission.
Note: The maximum power available for the external device is 12V @ 250mA.

Once powered, the Node then rapidly scans all inputs, switches to transmit mode and sends the data to the configured destination. It then switches back to receive mode to accept the acknowledgement before de-activating the Alarm relay and returning to the sleep condition for a further programmable sleep period.

The transmit and receive periods, will vary in accordance with network activity, but should be approximately 100mS each. During the sleep periods the Node only draws 400uA. It draws the normal current during the transmit and receive periods. During the pre transmit on-time the Node will draw the same as in the receive state.

Note: In this mode of operation the alarm relay is used to switch an external device and is therefore not available for normal alarm operation.

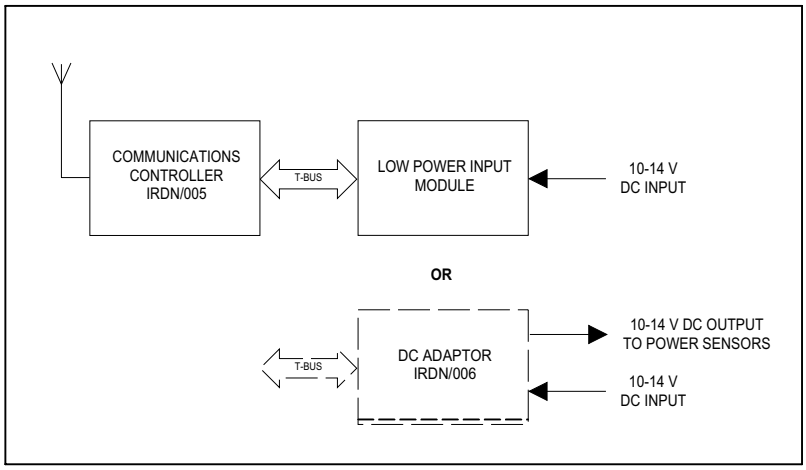


Figure 4 Low Power Node with Power to External Device

b. Low Power Receiver (Sniff Mode)

In this mode, the Node is powered down for 1.9 seconds out of every 2 seconds. During the remaining 100mS, the Node powers up, initialises the receiver and looks for a carrier on the channel. If a carrier is detected (on the channel but not necessarily for that Node) the Node powers up and receives the message.
If the message is not for this Node, it powers down. If it is for this Node, the Node will act upon the message and power down when the action is completed.

The transmitting Node will send out a long preamble (2.5 - 3 seconds) to get the attention of the Low Power receiver. It is recommended that the Transmitter is programmed for at least 2 re-tries.

The Node draws only 400uA during the sleep period but draws the normal current during transmit and receive periods.

Any transmitter always assumes it is talking to a Low Power receiver, when it first communicates. Once a successful communication has taken place, the Transmitting Node remembers which Nodes are Low Power and from then on sends the long preamble to those Nodes.

c. Low Power Transmit and Receive

It is possible to programme a VersaNet2 Node to operate in both Low Power Transmit and Low Power Receive mode simultaneously. The Node will operate exactly as described in section 'a' above, except that during the normal sleep period, the receiver will be 'sniffing' every 2 seconds, looking for carrier.

d. External Wake-up of Low Power Node

A Node configured as a Low Power Node may be woken up by changing the state of the digital input (D0.1) on the Communications Controller. Once awake, the Node will operate as specified under sections 'a', 'b' and 'c' above, as configured by the user. Each time the Node is woken up, it sends the status of all its inputs to their programmed destinations.

3.5 Enclosure Selection

In order to actually select the size of enclosure required and hence procure the correct parts, more information is required. By now, you will have drawn up a list of the modules required at each Node. Using the table below, calculate the total height of all modules in each Node:

Module Number and Name	Height/mm
IRDN200 Communications Controller	32
IRDN201 Digital Output	22
IRDN202 Digital/Pulse Input	32
IRDN203 Combination Input	47
IRDN206 DC Adaptor	32
IRDN207 Analogue Input	22
IRDN208 Analogue Output	22
IRDN209 Pulse Output	22
IRDN210 Combination Output	32
IRDN211 Low Power Input	32
IRDN212 Low Power Pulse Input	22
IRDN214 Alarm Output	32
PSU1291 1.0 Amp Power Supply	30
PSU1292 2.0 Amp Power Supply	40
PSU1293 3.0 Amp Power Supply	40
PSU1289 3.0 Amp Power Supply/Battery Charger	80

Table 6 Module Heights

Depending upon the number of Depth Extensions fitted, the available height of the enclosure is:

Enclosure Construction	Available Height
Basic Enclosure only	108m
Basic Enclosure + 1 Depth Extension	158mm
Basic Enclosure + 2 Depth Extensions	208mm

Table 7 Enclosure Heights

Where the height of the modules exceeds 208mm or available height is restricted, side extensions (ENC/002) may be used to link enclosures. Where space permits,

side extensions may also be used to improve access to terminations.
See Section 8.1 for details.

3.6 Antennas

Any antenna with a 50 ohm impedance designed for use at the relevant operating frequency band may be used, with the selected type dependent upon the application. The radio range achieved will be dictated by the land topography between the Nodes. In general, at UHF, good communications will be achieved up to 20km with 500 mW of power if there is line-of-sight. For applications where clear line-of-sight is not possible, the link integrity may be tested using the Received Signal Strength Indicator (RSSI) of VersaNet2. In many situations, raising the height of an antenna can dramatically improve performance.

With VersaNet2, additional Nodes can always be inserted as 'Relays' to increase the overall system range. A particular feature of VersaNet2 is that every Node can act as a repeater, therefore every Node is a potential relay point.

Antennas can be connected to VersaNet2 in two ways. The first is for enclosure-top antennas, such as the RDT part ENC206, which is connected via the Antenna Mounting Kit (ENC003), fitted to the top of the enclosure. Alternatively, different types of antennas may be connected via a suitable RF feeder cable to the N-type female socket provided by the Antenna Bulkhead Cable kit (ENC007). This is fitted to the gland plate in place of a cable gland.

Three different types of antennas cover the majority of applications, as shown in the table. These details are only a guide and the precise antenna performance may vary in different applications and between different manufacturers.

Antenna Type	Range	Coverage	Gain	Mounting	Applications
½ Wave Whip	Up to 1 Km	Omnidirectional	-3dB	Enclosure top	Short range, general
End-fed Dipole	Up to 10 Km	Omnidirectional	0dB	Pole Mounted	Medium range, general
8 Element Yagi	Up to 20 Km	Directional (40º)	10dB	Pole Mounted	Long range, directional

Table 8 Antenna Types

3.6.1 Feeder Cables

Many different types of RF feeder cables are available, designed for different applications. For most VersaNet2 applications the following types are suggested:

Cable type	Ohms	Loss dB/10m	Max suggested length
URM67 or RG213/U	50	2	25m
Heliax LDF-250	50	0.8	75m

Table 9 RF Feeder Types

3.7 Configuring a Node

Introduction

The following steps must be carried out to ensure your VersaNet2 system is correctly constructed, configured and installed.

1. Plan your system, noting all Node locations, I/O connections and signal routes.

2. Connect power to each Node.

3. Configure each Node to meet the requirements of the plan, using VNMGR

4. Securely install each Node, its associated antenna system and connect Input/Output (I/O) terminations as required.

5. Run Commissioning and Test routines on each Node.

6. Check all terminations and then secure enclosure lid (if used).

Note: The Node may be configured on site, after installation, if preferred. It is however generally easier to programme the Nodes in advance working in an office environment. An alternative is to prepare the configuration files in the office and save them ready for simple download on site.

The following sections 3.7.1 to 3.7.3 give a brief overview of the Node configuration procedure. Refer to Section 4 for a complete guide to the features and facilities available through the VNMGR software.

3.7.1 Module Hardware Configuration

Configuration of the I/O modules consists of setting the DIL switches marked SW1 & SW2 on each of the expansion modules (see diagram).

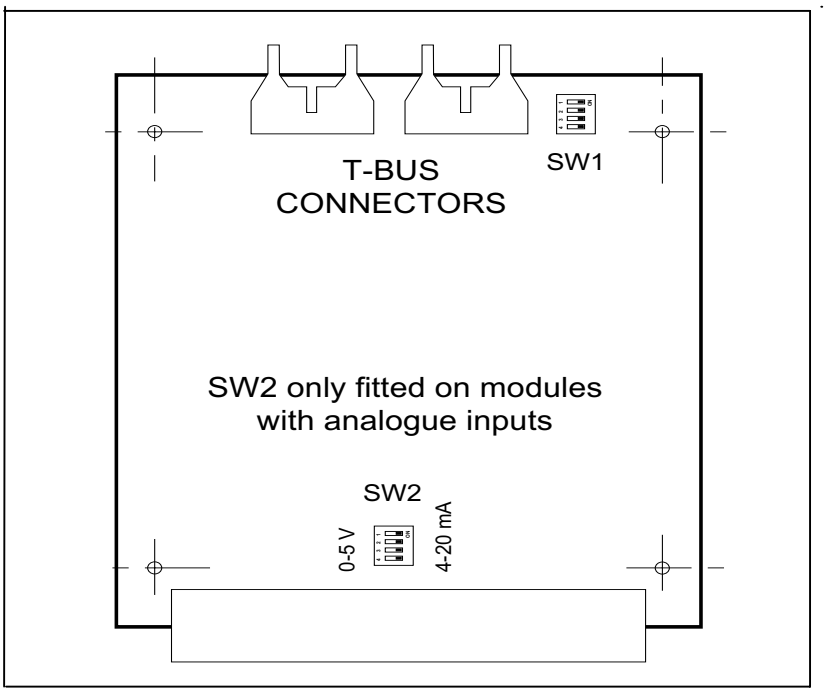


Figure 5 Location of DIL Switches on Modules

DIL switch setting should be performed without power connected. Each I/O module should be set to a unique address for that module type in a Node. For example, up to sixteen Digital Output modules may be used in a single Node, with the DIL switches on the modules set from one to sixteen. The actual switch positions required are shown in Table 6.

SW1 SETTING				ADDRESS
1	2	3	4	
On	On	On	On	1
Off	On	On	On	2
On	Off	On	On	3
Off	Off	On	On	4
On	On	Off	On	5
Off	On	Off	On	6
On	Off	Off	On	7
Off	Off	Off	On	8
On	On	On	Off	9
Off	On	On	Off	10
On	Off	On	Off	11
Off	Off	On	Off	12
On	On	Off	Off	13
Off	On	Off	Off	14
On	Off	Off	Off	15
Off	Off	Off	Off	16

Table 6 DIL Switch Settings

The Digital/Pulse Input module is configured in software to accept Digital or Pulse inputs for each of the eight input channels.

In addition to this configuration, the Analogue Input Module, Combination Input Module and Low Power Input Module may also be configured to accept either analogue voltage or current inputs. This is done by switching the DIL switch, SW2, shown in Fig 5, between "Volts" and "mA" for each channel.

Communications Controller

The Communications Controller Card has a number of Switches, Links and Connectors with the following functions.

Switch 1 (SW1). 4 way DIL switch.

SW1/1	OFF normal operation	ON factory test only
SW1/2	OFF normal operation	ON factory test only
SW1/3	OFF normal operation	ON factory test only
SW1/4	ON Normal operation	OFF turns off LED's

SW1/4 may be used to switch off LED's, on a low power Node, to reduce current.

Link 1	RUN Normal operation or PGM programming mode (see Sect 2.3)
Link 2	Sets Analogue input to V (1-5volts) or mA (4-20 mA)
Link 3 & 4	Sets Digital input to LP (low power mode) or ISOL (normal mode)
Link 5 & 6	Sets Pulse input to LP (low power mode) or ISOL (normal mode)

JP 1 & JP 2	10 way IDC connectors for the T-BUS
JP 3	Not fitted
JP 4	Set jumper to position 5 for mains operation and position 3 for battery operation. In position 5 the unit will stop working if the DC falls below 10v indicating a mains failure. In position 3 a battery low alarm will be given at 10v although the unit will continue working below 10v (at reduced power).
JP 5	16 pin connector for Radio Module
JP 6	Factory test only
JP 7	9 Way 'D' plug for configuration port
JP 8	5 Way plug for Digital I/O
JP 9	3 Way plug for Alarm output
JP 10	4 Way plug for Analogue I/O

JP 11 4 Way plug for Pulse I/o
JP 12 9 Way 'D' plug for Data Highway port
JP 13 2 Way plug for DC input.

See Section 7, Technical Specification for pin connections and current ratings.

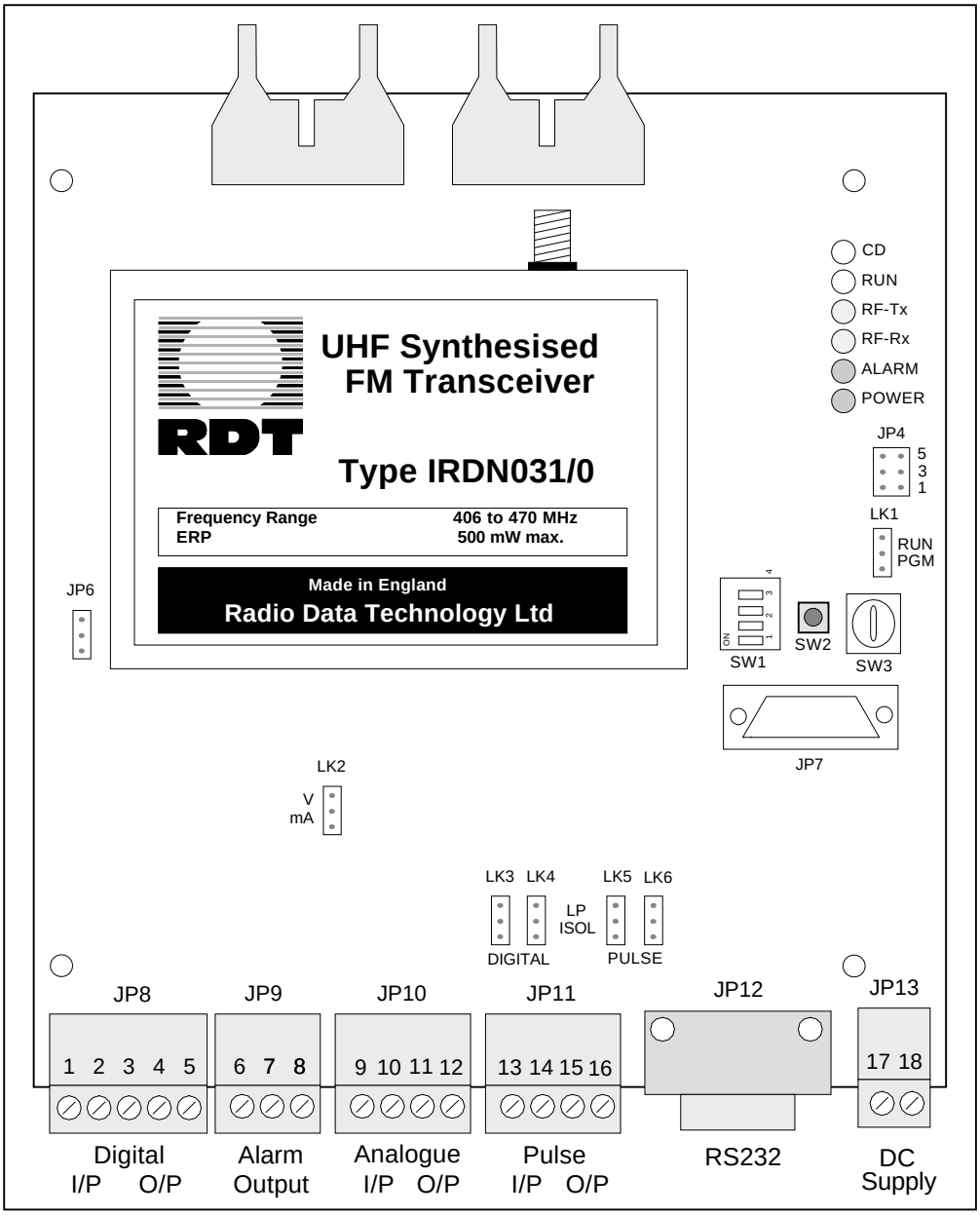


Figure 6 Communications Controller Module

3.7.2 Node Software Configuration

Before a Node can operate, it must be configured with information concerning its role in the system and any data it has to handle. It is the Communications Controller module in each Node that is configured with this information, stored in

non-volatile memory. In addition, where applicable, each I/O module must be configured to its address within a Node using DIL switches.
Note: The controller module is normally supplied with NODE software installed. If for any reason you need to install software or upgrade to a new version, see Section 2.3 for details.

3.7.3 Using VNMGR

Connect the configuration cable supplied to the correct port of the PC and connect the other end to JP7, the RS232 Port, on the controller. Power the Node and wait until the Node has initialized. This is indicated by the following LED's, Red power 'on', amber RX 'on' and green run 'on' in steady state, not flashing. This takes a few seconds.

Open VNMGR on the PC. Watch the Icon in the top right corner. Blue dots will travel from the Node Icon to the PC Icon. This is the PC uploading data from the Node.

Select the Node Configuration pull down menu, and select 'New' or 'Receive from Node'. The latter will upload the current settings, which can be overwritten.

Fill in the boxes on the Network screen. Note; if a GSM modem only is to be used on the Node, tick the GSM only box. The radio parameter fields are then greyed out because they are not relevant.

Use the tabs at the bottom of the screen to move to the other screens.

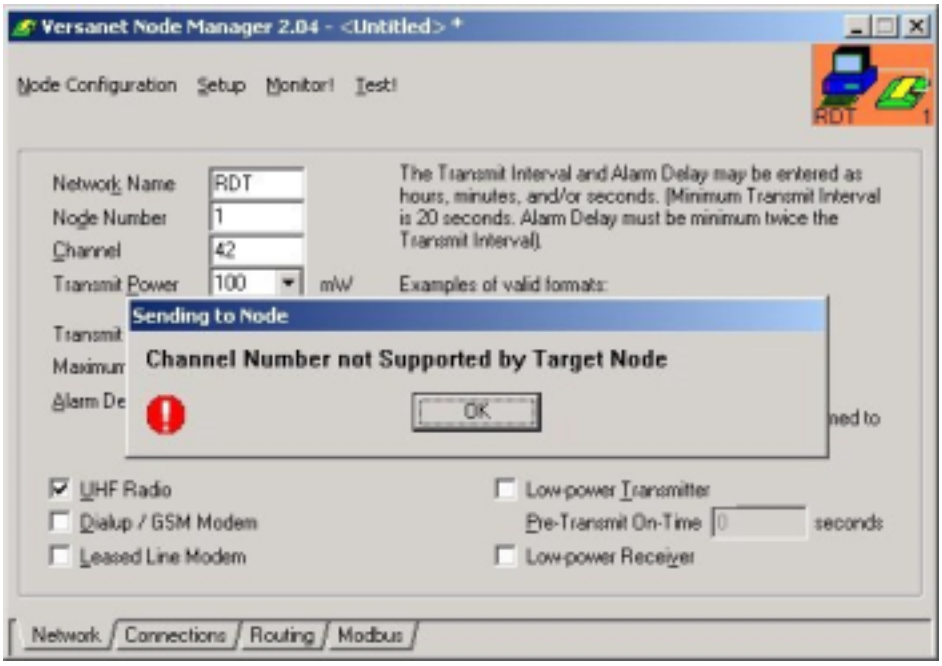
Complete the Connections screen with all the I/O information for the Node. Note: all the module cards that are connected will be displayed on the left of the screen. Each can be opened out to show the I/O available.

Complete the Routing screen, if required. This information is needed for networks with multiple Nodes so that each repeater stage has details of the route to the final destination.

Complete the Highway screen only if GSM, wire line modems or Modbus are being connected to this Node.

Complete the SMS and Dial-up screens only if a GSM or external wire line modem are being connected.

Note: if any of the boxes are completed incorrectly, warning messages will appear asking you to make a correction.



Screenshot 1 Warning Message

Once all the information is complete, select the Node Configuration pull down menu and select 'Send to Node'. Watch the icon in the top right corner and red dots will travel from the PC icon to the Node icon, indicating downloading.

There is also information under the icon on the download status. This process may take a few minutes depending on the speed of the PC and the file size (number of connections etc.).

Screenshot 2 Download Icon

As soon as the download is completed, power the Node down, wait a few seconds and power up again. This ensures that the Node will reset to all the new parameters and connections. The Node is now operational.

Section 4 VNMGR

Introduction

A VersaNet2 Node is normally supplied with the NODE Software already installed. If you need to install new software or update to a later version, see Section 2.3 for full details on software installation.

The VNMGR programme does not alter the Node software, but it allows the user to configure parameters, which are then downloaded and stored in non volatile memory.

Before configuring the Communications Controller, if any other I/O cards are fitted to the Node they must have their address set using the on board DIL switches. See Section 3.7.1 for switch settings.

4.1 VNMGR Introduction

VersaNet2 is a truly modular radio telemetry product offering unrivalled flexibility. Any VersaNet2 Node can have Digital, Analogue, Pulse and Serial Data I/O capabilities. The powerful configuration program permits any Input Channel to be sent to any Output Channel destination anywhere within the radio network. This concept enables the construction of simple 'point-to-point' links or complex multi-Node networks from a standard range of I/O modules, providing an efficient and economical solution for every application.

VersaNet2 normally communicates using UHF Radio Links but it also has the capability of using modems, wire line or GSM, to further increase its flexibility. Using a modem increases the range to virtually any geographical location well outside of the range of the UHF Radio. A Node can be configured to use UHF Radio only, an external modem only or a combination of both. A GSM Modem may for example be configured as a back-up (secondary route) in case of failure of the main radio path.

The VersaNet2 Communications Controller is supplied with VersaNet2 Manager configuration software (VNMGR). This software runs on a standard PC under Windows 95 (or later) and facilitates the rapid installation of a VersaNet2 system. See Section 2.3 for more details on system requirements and installation.

4.2 Preparing for Configuration

Each VersaNet2 Node must contain a Controller module and, optionally, a selection of I/O modules from the standard range available. It is the Controller that must be configured using the VNMGR software supplied with the system.
In addition to the software you will require a PC running Windows 95 (or later) and a configuration lead (serial data cable) which is supplied with the Controller.

Connect one end of the configuration lead to the appropriate serial port (RS232) on the PC. The other end of the lead must be connected to the RS232 configuration port (JP7) on the Controller. See Figure 6 Section 3.7.1 for board layout.

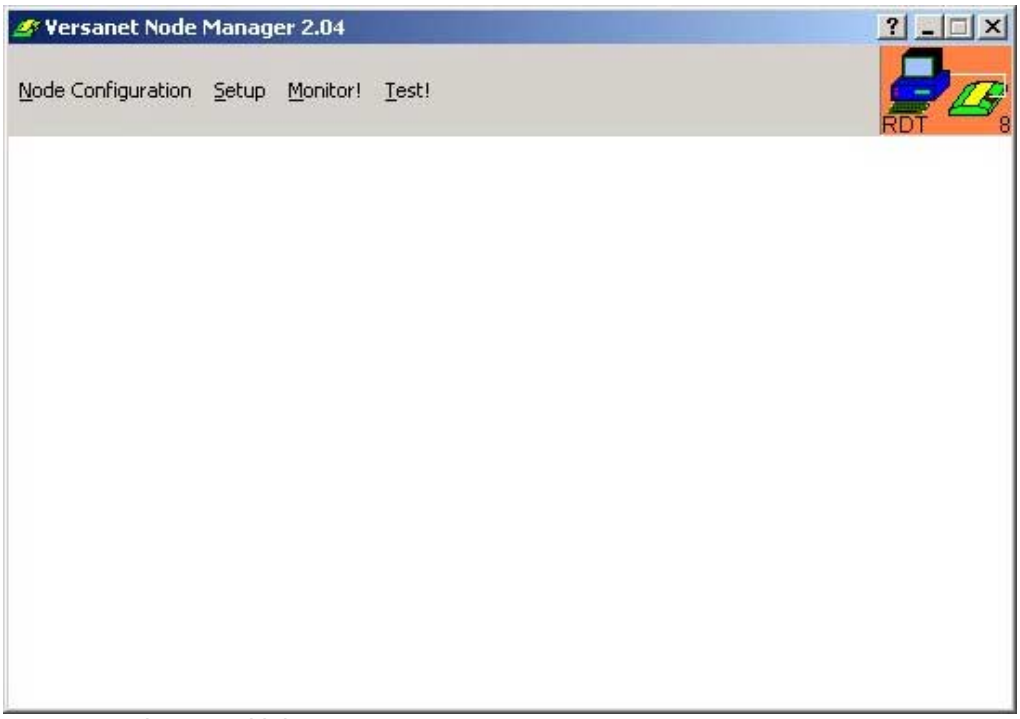
4.3 Accessing the Configuration Software

Install the VersaNet2 Manager software (vnmgr2-XX.exe) onto your PC by following the instructions printed on the floppy disk or CD supplied with your system, or as follows:-

- Insert disc into floppy drive 'a' (or CD in appropriate drive)

- View the directory of drive ‘a’ (or CD) using explore
- Copy the vnmgr2-XX.exe file to your preferred folder and create a shortcut
  or
  Drag the VNMGR Icon directly to the desktop

Note. The version of the software is indicated by the number 2.XX i.e.2.01, 2.02 etc.
Once installed, access the software by ‘double-clicking’ the VersaNet2 Icon on your screen.
When the software has loaded the following screen will be displayed:-



Screenshot 3 Initial Screen

The next step is to select the correct COM port for sending and receiving data to the Controller. This is achieved by selecting the **Setup** drop down menu at the top of the screen. Next select **Port** and you will see a list of available COM ports for this PC. Select the correct COM port from the list shown. The software will always default to this COM port in future.

In the top right-hand corner of the screen you will see a colour graphic which shows a PC and Controller. Assuming that the Controller is powered and the configuration lead is connected correctly, a thin white line should be visible connecting the PC to the Controller Icon and the Controller Icon will be green/yellow in colour.

If the white line is not visible and the Controller Icon is displayed in dark green then there is no communication and you must check the Configuration Lead, the power supply to the Controller and the Setup Port selection to find the problem. Note: when first connected it may take several seconds for communication to be established.

When you first access the VNMGR software, all the static data from within the Controller is uploaded. Static data refers to parameters that are factory set within the radio and cannot be modified using the VNMGR software, such as, Radio Serial Number, Operating Frequency Range, Max number of radio channels, Channel Spacing etc.

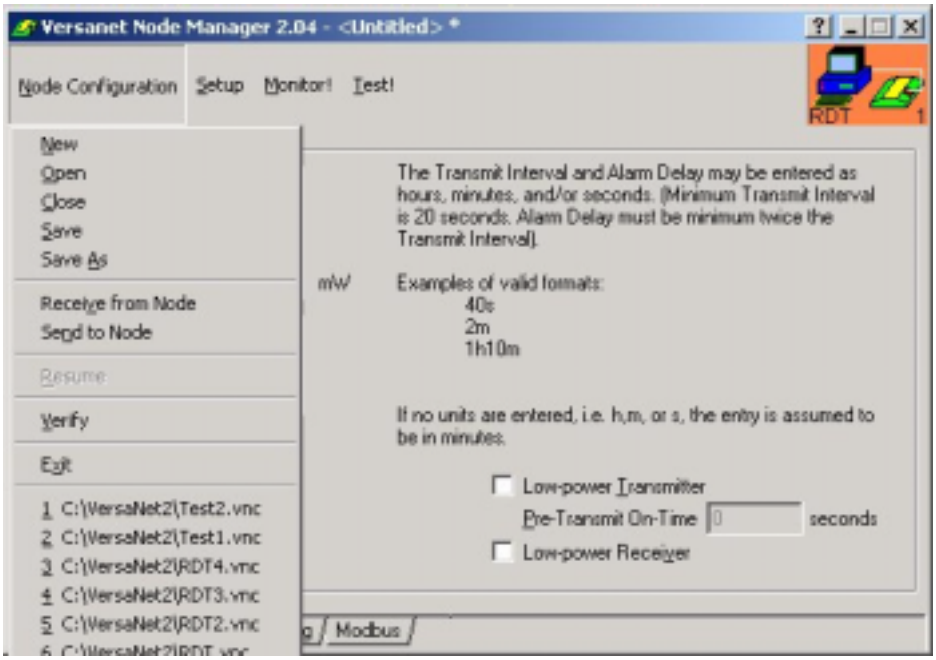
Screenshot 4

In addition, the T2-BUS on the Controller is scanned and all I/O modules connected are automatically detected and reported to the VNMGR software for use during the configuration process.

Uploading of the above information is indicated on-screen by a blue dot traveling along the white line, which connects the PC to the Controller Icon.

4.4 Node Configuration

Selecting **Node Configuration** from the on-screen options will display the following drop down menu:-



Screenshot 5 Drop Down Menu

4.4.1 Drop Down Menu 'Node Configuration'

The following is a brief description of the available options.

New This will open a completely new VNMGR configuration template, with all fields blank. If you have a current configuration file open, you will be prompted to save or discard the file before opening a new template.

Open Allows previously saved configuration files to be opened. If for example, several Nodes are being programmed and they all have similar connections, once the first has been configured, save the file and use it for the other Nodes. The saved files are also useful when installing a spare Node.

Close Closes the current configuration file. You will be prompted to save or discard the file before closing.

Save Allows the currently open file to be saved.

Save as Allows the open file to be saved under a new name and location.

Receive from Node Uploads the existing file from the Connected Node.

Send to Node Downloads the current file to the Node.

Resume This is used to return to the programming screen from either the Monitor or Test screens.

Verify After entering all the programming information verify can be used to check the information prior to downloading.

Exit Closes VNMGR and returns to Windows.

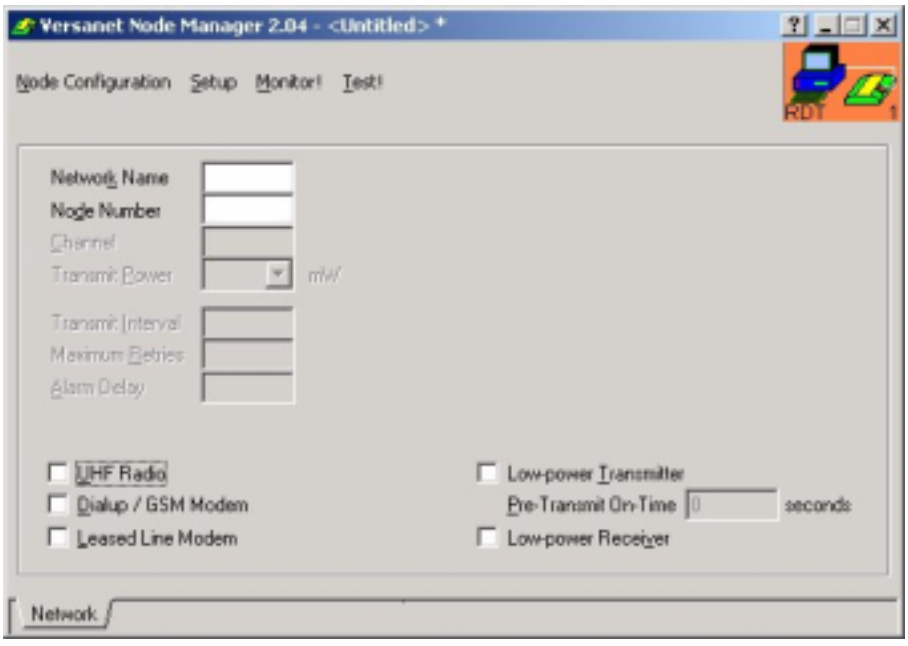
4.4.2 Drop Down Menu 'Setup'

After selecting **Setup,** select the correct COM Port for your PC from the list shown. The software will always default to this COM Port in future.

Screenshot 6

4.4.3 Entering a New Configuration

Select **Node Configuration** from the on-screen options followed by **New**. The following screen is displayed:



Screenshot 7 New Screen

By default, the **Network** Tab is selected which permits you to configure all of the Network parameters as follows:-

Network Name
Enter a Network Name which must be common to all Nodes in the network. Valid characters are A-Z, 0-9 and Space. This field can be any combination of letters and numbers up to a maximum of 5 characters.

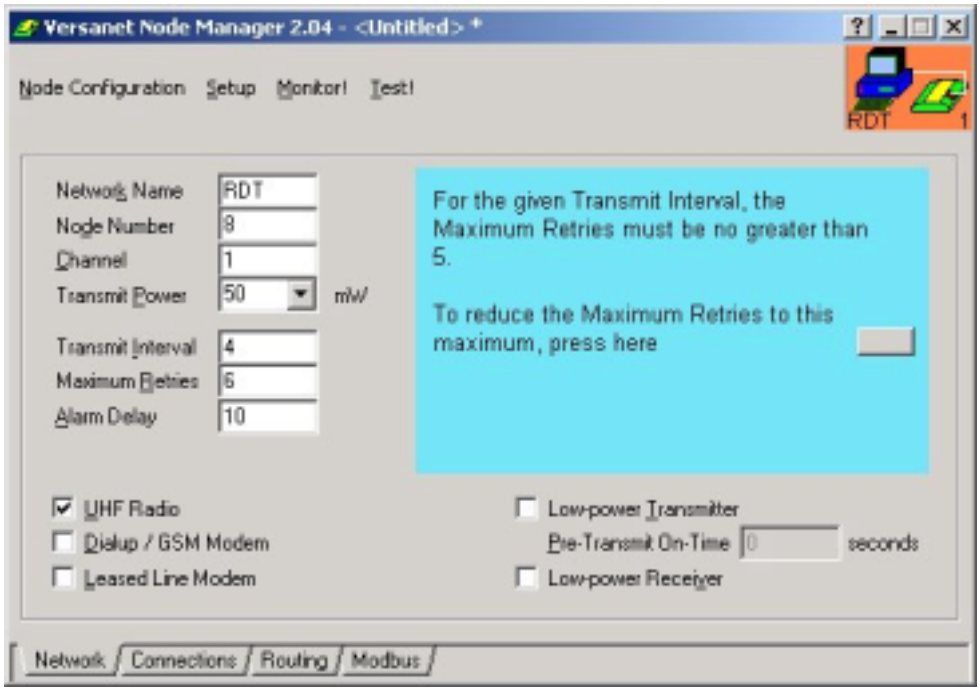
Node Number
Enter a Node Number in the range 1 to 254 inclusive. This is the unique identifier for this Node within the Network.

Note
At this stage, select the type of communication to be used for this Node. If a UHF radio is to be used on this Node, tick the box at the bottom left, this will activate the greyed out radio parameter fields, which should then be completed.

Channel
Enter a valid RF channel between 1 and the maximum available. All Nodes within the Network must be set to operate on the same channel. The channel/frequency allocations are supplied with each IRDN200 in the form of a single A4 sheet of paper. The maximum number of channels available can also be found on the TEST screen.

Transmit Power
Enter a value between 50 and 500 (mW) inclusive or select one of the pre-set values from the drop-down menu.

Transmission Interval
Enter the transmission interval between 20 seconds and 24 hours (in increments of 10 seconds). Times can be specified in seconds, minutes or hours. (See on screen notes). This value specifies how often the Controller will scan all inputs and transmit their status to other Nodes on the Network.



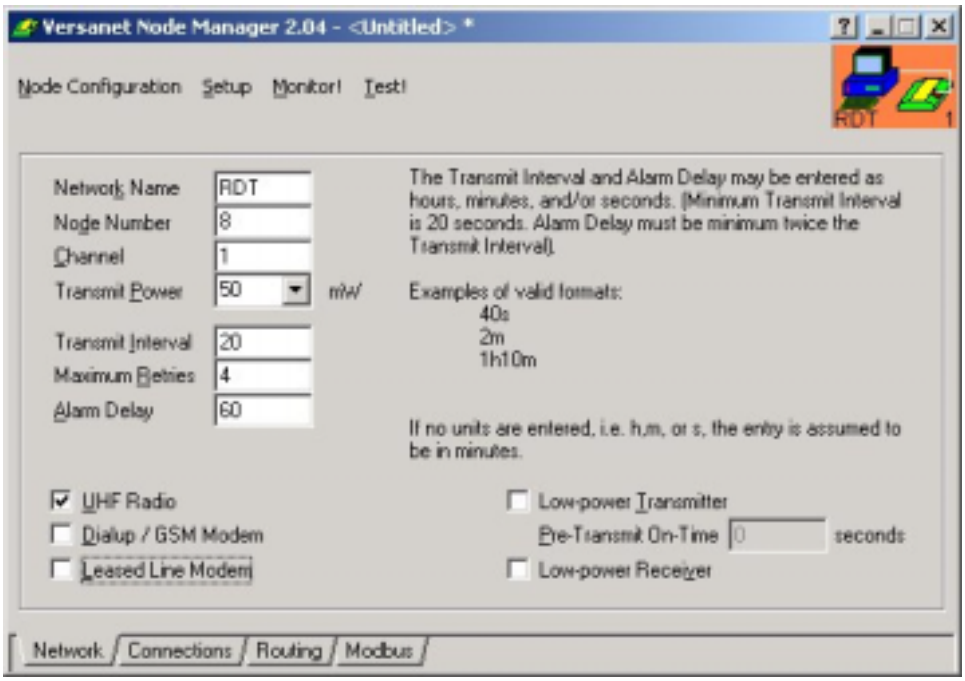
Screenshot 8 On Screen 'Wizard'

Maximum Retries
Enter a number between 1 and 9 inclusive. All Node transmissions are acknowledged and this field allows you to specify the maximum number of transmission attempts that can be made before the controller reports a failed acknowledgement (communication). The number of retries is related to the transmission interval. For example, with a short transmission interval, it is not sensible to programme a large number of retries, because the Node would be attempting to transmit continuously. The limits are therefore:-
under 1 minute TX interval, 1 retry;
under 2 minutes TX interval, 2 retries etc.
If numbers are entered outside of these limits, an on screen messages (Wizard) appears, to alert you and adjust the number of retries within these limits.

Alarm Delay
Each Controller is equipped with an Alarm LED and an Alarm Relay Output on (JP9). Every transmission to another Node is Acknowledged (Ack) to indicate correct receipt of the data. If no Ack. is received from the target Node, the alarm timer is started. If no valid Ack. is received from that target Node over the alarm delay period, the alarm will activate. Note that only an Ack. from that target Node will clear the alarm. Acks. or Transmissions from any other Node, will not clear the alarm.

The relay alarm output is a changeover switch that is normally in the energized state on a healthy Node. Note that in Low Power Modes (see below and Section 3.4.10) the alarm is disabled as the alarm relay is used for other purposes.

The Alarm Delay period should be set to a minimum of twice the TX interval. This is so that 1 single missed transmission will not immediately cause an alarm. (It is possible that a radio communication will be missed for a number of reasons such as, radio interference, abnormal weather conditions etc.). An on screen message will alert you if the alarm delay is set too low. It may be set for up to a maximum of 48 hours.



Screenshot 9 Typical Completed Network Screen

For special applications an alarm delay of zero may be selected. Remember, in this case the alarm will trigger immediately a single communication failure occurs. For this reason, zero alarm delay is not generally recommended.

Modem (GSM or Wire Line)
It is possible to configure a Node to use both UHF radio and a Modem (GSM or wire line), for example when the Modem is used for a back up (secondary route). If a UHF radio is to be used on this Node, check the first box. If a modem is used, check either the Dial-up or Leased Line box. For a Node using only a Modem and no UHF radio, un-check the UHF radio box. (This will grey out the radio parameters).
Note that the tabs at the bottom of the screen change depending on the selection. Only the relevant tabs are available.

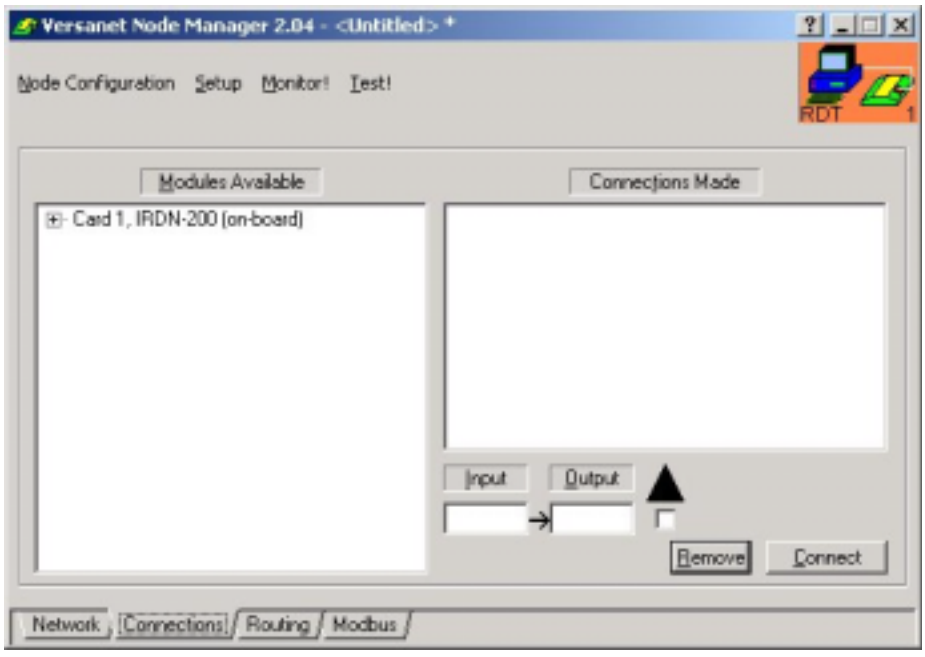
Low Power Transmitter
When selected, this check-box will configure the controller to operate as a Low Power Transmitter (refer to section 3.4.10). Note that if this box is checked, the 'Pre-Transmit On-Time' box is available. This should be used if the Node is being used to power an external device. The Node will be turned on for this period of time prior to transmitting so that the external device has time to stabilize. The range is between 0 and 60 seconds. Note: if no pre-transmit time is required, enter '0'.

Low Power Receiver
When selected, this check-box will configure the controller to operate as a Low Power Receiver (refer to section 3.4.10).

When all the above parameters have been entered you can proceed to the next stage of configuration, Connections, by selecting the **Connections** Tab in the bottom left-hand corner of the screen

4.4.4 Connections

The following screen is displayed after selection of the **Connections** tab on the Node Configuration screen:-



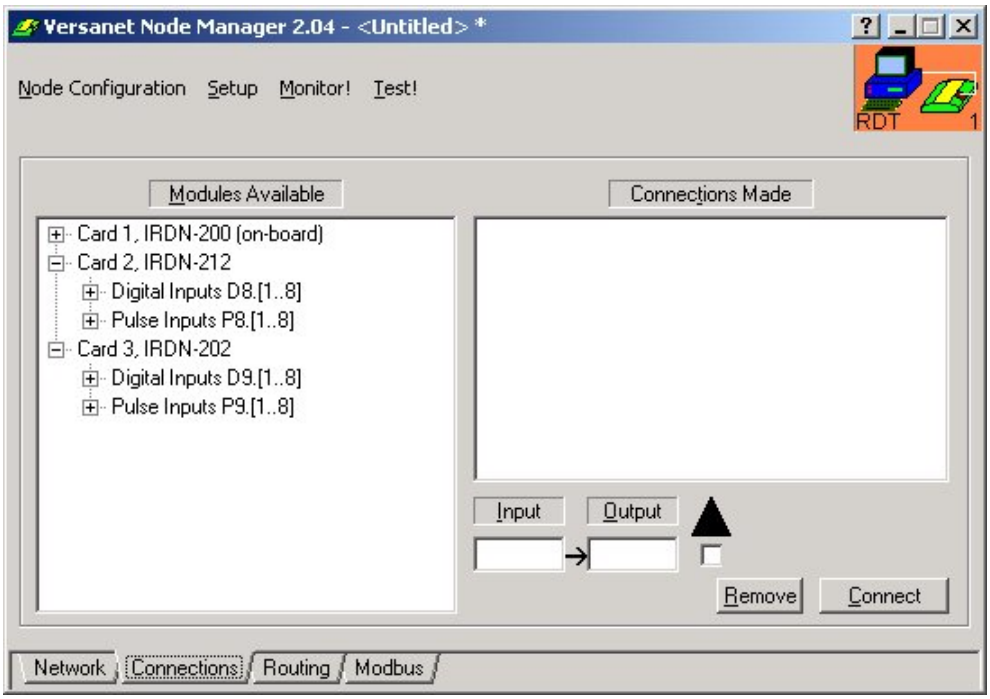
Screenshot 10 Connection Screen

Any Input Channel to be used within the Node must be sent to a corresponding Output Channel on another Node, somewhere within the Network. At this stage it does not matter if the Destination Node is within radio range because the Routing Table can be entered at a later stage (see Routing,)

The connections screen allows you to specify a destination output for all Input Channels found within the Node you are configuring.

The screen area marked 'Modules Available' displays an expandable tree view of cards available.

Selecting the **'+'** symbol next to the relevant card in the 'Modules Available' area, expands the view to display the available Input Channels on that Module. Subsequently, selecting an Input Channel (e.g. D0.1) immediately transfers the Input Channel address to the connections box labeled 'Input'. (Select an input by highlighting with a left mouse click). Alternatively the input address may be typed directly into the box.



Screenshot 11 Modules Available (Expanded)

Now you must specify where you want the Input Channel to be sent by selecting the screen area labeled 'Output' and entering a valid Node Number and Output Destination.
For example, entering 32D0.1 into the Output box will send the selected Input Channel to Node 32 and output it on Channel D0.1 (please refer to section 2.2, Data Handling, for more information on the addressing formats for VersaNet2).

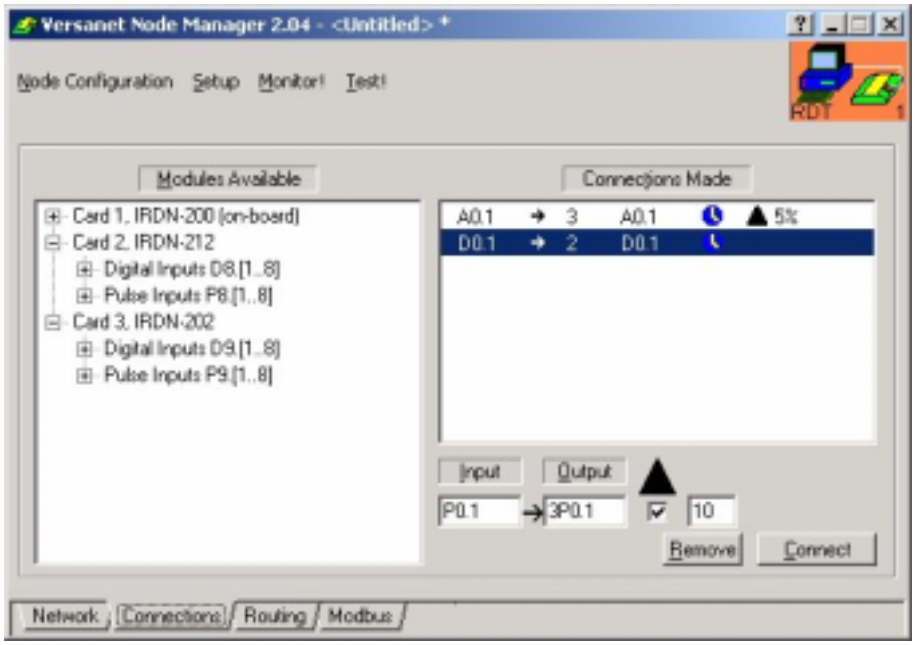
Immediately after the output destination box there is a 'state change' tick box, marked with a triangle. Checking this box allows you to specify the conditions under which a change in state of the input will cause a transmission. Note: A transmission will be sent indicating the status of all inputs at every transmit interval (defined on the Network screen). Checking the state change box will cause a transmissions to be sent, for that input only, immediately the input changes.

If the State Change Icon is selected and the Input Channel you are connecting is an Analogue, then you will also be asked to specify the percentage change that needs to occur before the Analogue value will be sent. For example, a % change of 10 will cause a transmission to occur every time the input value increases or decreases by 10% of full scale or more, since the last transmission.

If the State Change Icon is selected and the Input Channel you are connecting is a Pulse, then you will also be asked to specify the number of pulses that need to occur before the count will be sent. For example, a value of 5 will cause a transmission to occur every time the input value increases by 5 or more. Note: the count is cumulative so a total of 5 or more will cause a transmission.

Each time you complete an entry, the Connect button must be pressed. This transfers a summary of the connection made to the 'Connections' area on the screen. The connection process can be repeated for each Input Channel by repeating this process.

If you wish to remove/delete any connections simply highlight the appropriate connection in the Connections Made area on-screen and press the Remove button.



Screenshot 12 Completed Connection Screen

Note: If after you add a connection, the black triangle state change indicator is red, this indicates an error. It may be that you have selected Low Power TX or RX on the Network screen. Connections on event (state change) are not supported in Low Power Mode, (The Node is asleep and will not see the input change), except for digital input D0.1.

Pulse to Analogue

For special applications, it is possible to programme a pulse input to be sent to an analogue output. In this case, the pulses are counted and averaged over the TX Interval period. The total number of pulses received within the this period is then converted to an analogue value, corresponding to a rate of flow. This figure is then transmitted to the destination Node where it can be output and displayed.

When a pulse input is entered with an analogue output as the destination, other boxes appear so that the parameters can be added.

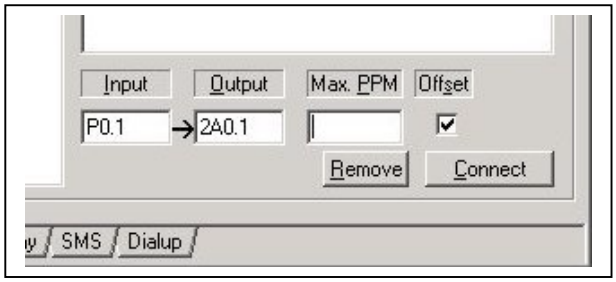


Figure 13 Pulse to Analogue

In the 'PPM' field enter the number of pulses per minute that will equal the full scale deflection. Tick the offset box to change the range from 0 – 20 mA to 4 – 20 mA.

Example:
Enter 20 in the PPM field.
This means that a rate of 20 pulses per minute will equate to full scale deflection, i.e. will output 20mA.
An average rate of 10 pulses per minute will therefore equate to 50% FSD and will output 10mA.
If your system is working on 4 – 20mA instead of 0 – 20mA, tick the offset box. The figures output will then relate to this scale.

4.4.6 Routing

Select the **Routing** tab at the bottom of the screen.

This facility allows you to specify the Routing table to be followed for all connections that you have made. A Route is defined as a radio path between three or more Nodes. Routing Tables must be established for every Node within the Network that cannot directly communicate with the Destination Node specified on the Connections list. This powerful facility permits the construction of complex Networks with many repeaters to circumnavigate obstructions or extend range.

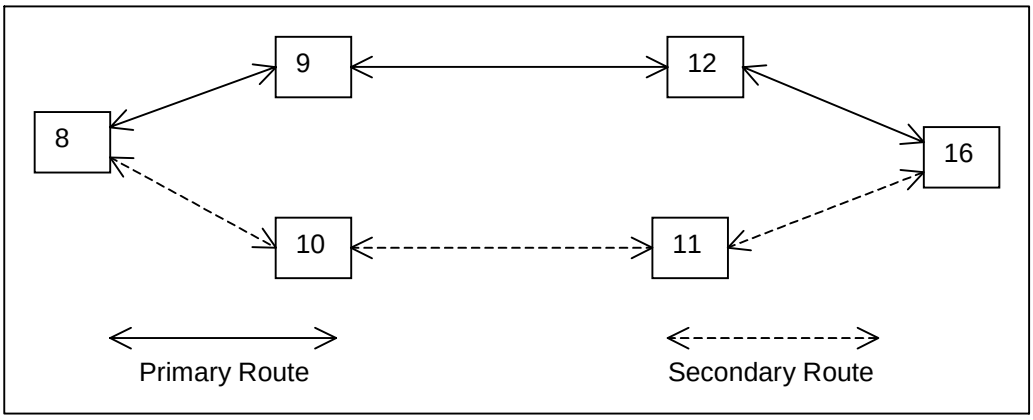


Figure 7 Example of Network Routing

Assume you are programming Node 8.
In the above example a connection is programmed from Node 8 to Node 9. There is no need for an entry in the routing table since Node 9 is adjacent to Node 8 and

does not require a repeater Node. Similarly no routing is required for a connection to Node 10.

A connection programmed from Node 8 to Node 16 however, requires routing information since Node 9 and 12 will be used as repeaters. To programme this route:
Make sure ‘Primary’ is selected
Enter ‘16’ in the Destination box
Enter ‘9’ in the Repeater box. (make sure ‘Repeater Node’ is checked)
Press the ‘Add’ button and the route will be transferred to the routing list.
Note that only the first repeater is programmed in the routing table. When programming Node 9 the route from Node 9 to Node 16 will be added.

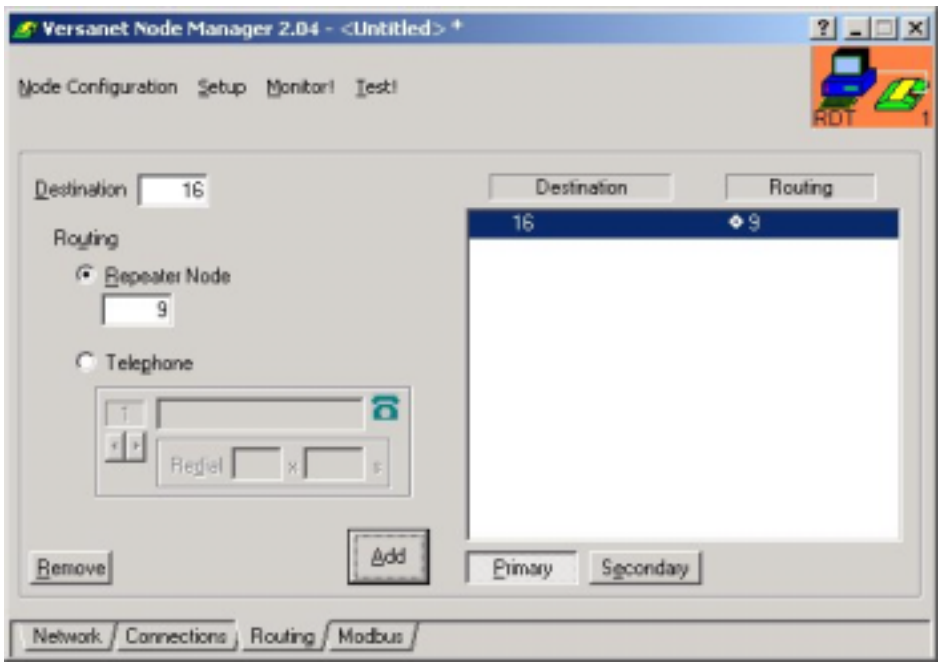
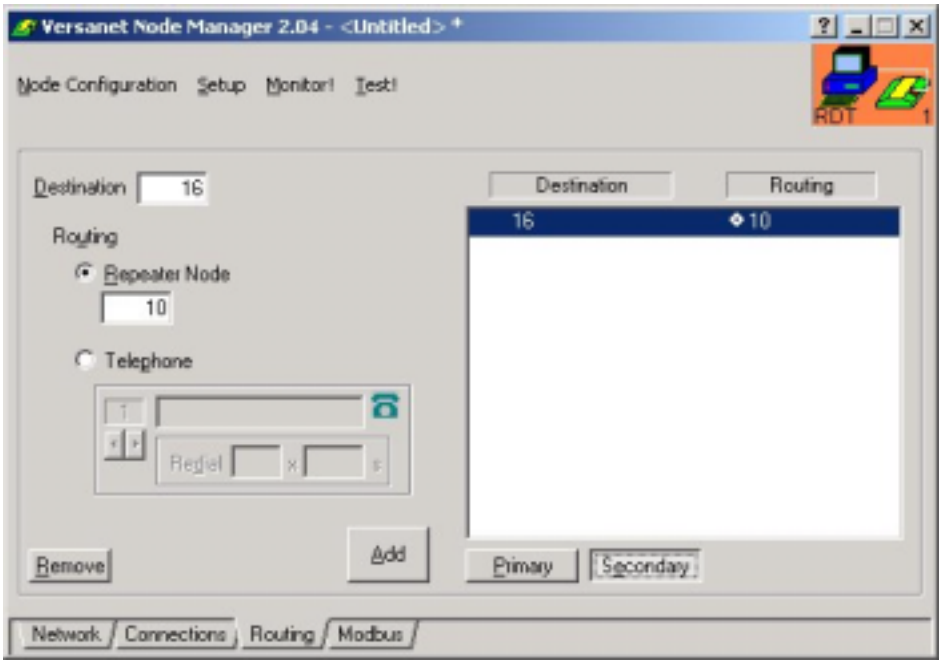


Figure 14 Primary Route

The facility exists to have two Routes for any particular Node, Primary & Secondary. The Secondary Route will only ever be followed if the Primary Route reports a communications failure.

In the above example, in Fig 7, a secondary route could be programmed from Node 8 to Node 16 using Nodes 10 and 11 as repeaters. If communication fails to Node 9, the secondary route via Node 10 would automatically be selected. To programme this route:-
Make sure ‘Secondary’ is selected
Enter ‘16’ in the destination box
Enter ‘10’ in the repeater box (make sure ‘Repeater Node’ is checked)
Press the ‘Add’ button
Remember, when programming Node 10 the route to Node 16 via Node 11 must be added.



Screenshot 15 Secondary Route Using a Modem Connection

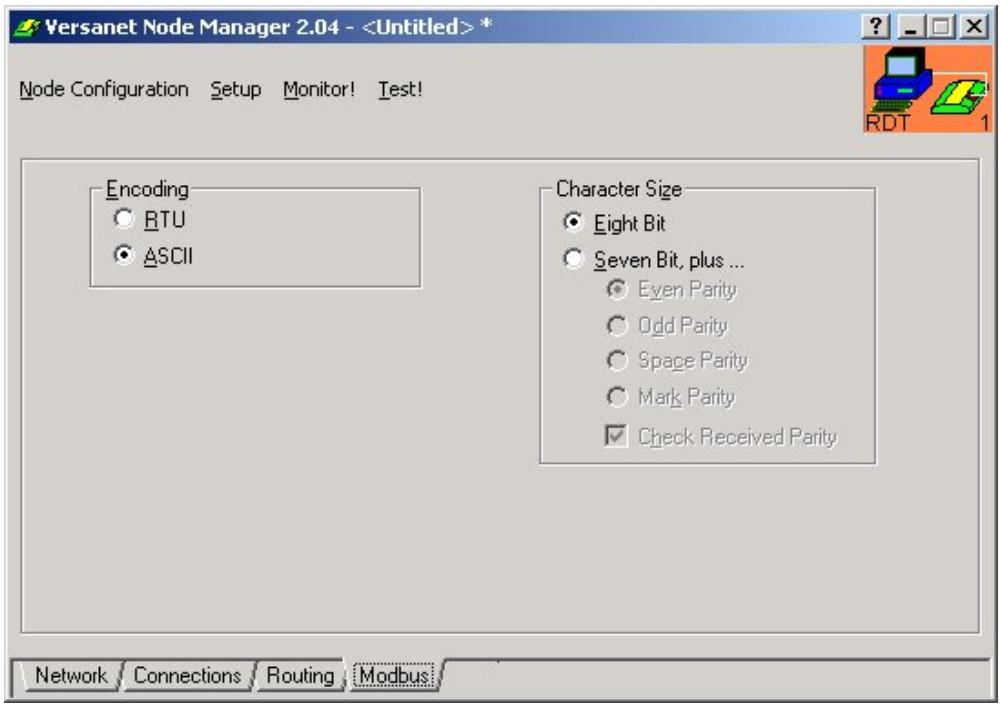
It is also possible to use a GSM or Wire Line Modem for either a Primary or Secondary route. Follow the same principle as above but this time check 'Telephone' instead of 'Repeater'. Enter the telephone number of the destination Node. Note that unlike uhf radio, the destination Node for modem connection can be anywhere and need not be the next adjacent Node in the chain. Once the telephone number has been entered add the number of retries and the interval in seconds. The Node will then, if unsuccessful the first time, automatically dial that number of retries at the specified interval.

Each telephone number has an index number associated with it for reference. These telephone numbers are stored on a list, which is used by the routing screen and the dial up screen. In other words telephone number 3 will be the same on both screens, change it on one and it changes on the other. You can scroll through the numbers using the arrow keys. Up to 32 telephone numbers may be entered.

If a GSM Modem is used for a Primary route note that it will dial out and send the status of all inputs at the interval set by the TX interval on the Network screen. If you only require the GSM to be triggered by special events use the Dial-Up screen for programming.

4.4.7 Modbus

Select the **Modbus** tab from the bottom of the screen.
This screen is only required if you are using a Modbus interface, such as a SCADA package.



Screenshot 16 Modbus Screen

For Modbus operation Select 'RTU' or 'ASCII'. Check with your SCADA package which version you are using. Also check the details required for the RS232 Protocol and fill in the 'Character size' section accordingly.

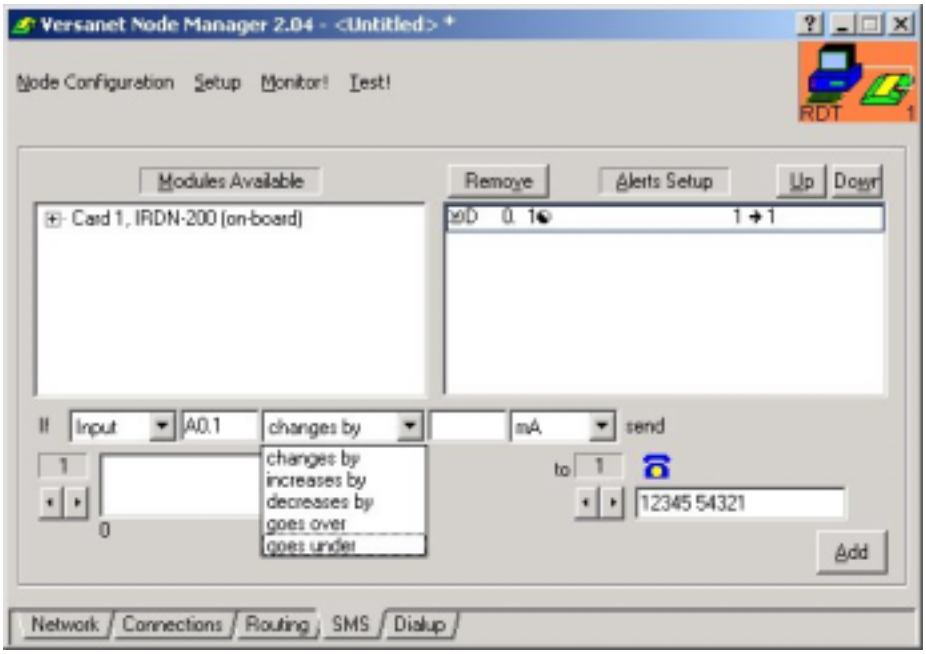
4.4.8 SMS

Select the **SMS** tab at the bottom of the screen.
This screen is only required if you are using a GSM modem with SMS messaging.
The 'Modules Available' is the same as the Connection screen. Modules can be expanded to show all available I/O.

The SMS is programmed so that if a certain defined set of conditions occur (a trigger or alert), a pre-defined message is sent to a specific telephone number. (i.e. a service engineer with a GSM mobile).

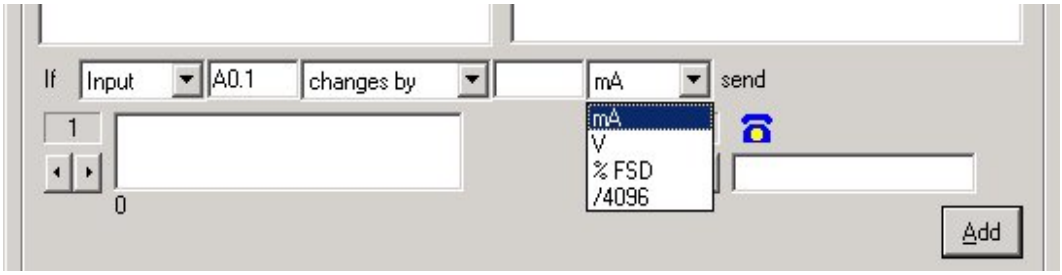
a. Defining the Alert (Trigger)

As with the Connection screen, either select an input or output from the Modules Available list or type the information directly into the input box. Select the trigger condition from the drop down menu in the third box.



Screenshot 17 SMS Screen with Analogue Input

The above example shows the conditions for an Analogue Input. After selecting the trigger condition, set the parameters in the following two boxes using the drop down menu options for the fourth box. The operation is similar for Digital or Pulse Inputs and all outputs.



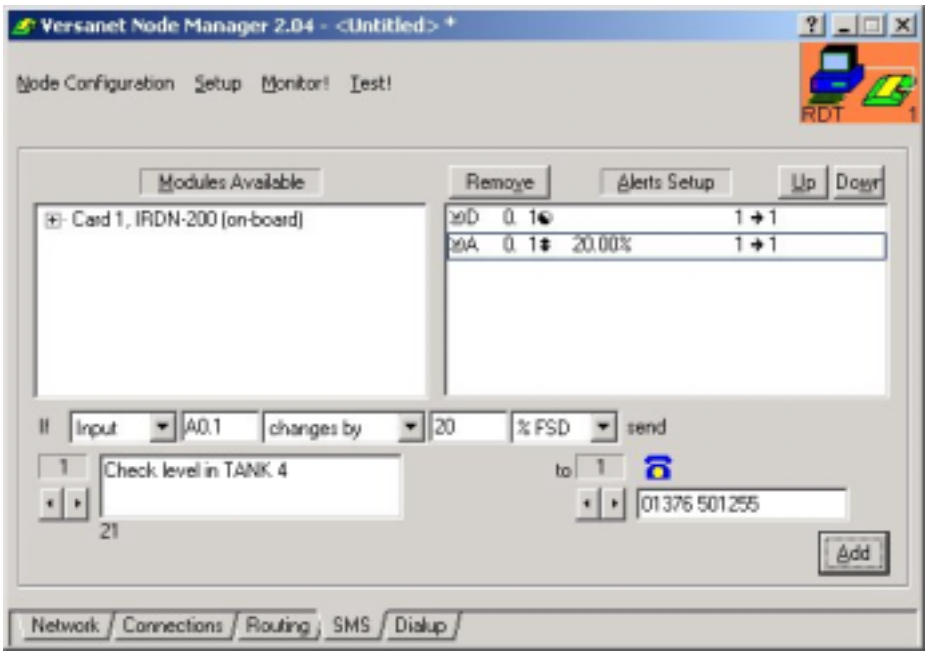
Screenshot 18 Analogue Drop Down Options

It is possible to use a 'Virtual' output to trigger an SMS message. Programme this in the same manner as above as an 'output'. Note, by using a Virtual output on this Node to trigger an SMS, a corresponding input on any Node in the network can be used to send SMS messages from this Node.

b. Defining a Message

For each SMS, a message must be entered in the message box. This can be free text of up to 160 characters per message. Note: a cumulative character count is shown under the message box. Each message is assigned an index number for reference. Using the arrow keys you can scroll through the messages. If required, the same message can be assigned to a number of I/O conditions. (i.e. different triggers can be used to send the same message). It is also possible to embed a variable string within a message. (Contact RDT for a separate data sheet).

Note: Up to 32 separate messages may be defined, of up to 160 characters each to a cumulative maximum total of 2,000 characters.



Screenshot 19 Example Message and Telephone Number

c. Telephone Numbers

Once the trigger conditions have been set up and the required message composed, enter the required destination telephone number in the box marked with the telephone icon. Again, each telephone number has an associated index number for reference. You can scroll through the numbers using the arrow keys.

Once you have associated a particular trigger with its message and telephone number, press the 'Add' button and the details will be transferred to the 'Alerts Setup' table. Using the arrow keys you can scroll through the alerts list and delete a highlighted selection if required. A number of different messages can be sent to the same telephone number.

Note: These telephone numbers are not linked to the Routing or Dial-up screen telephone number list.

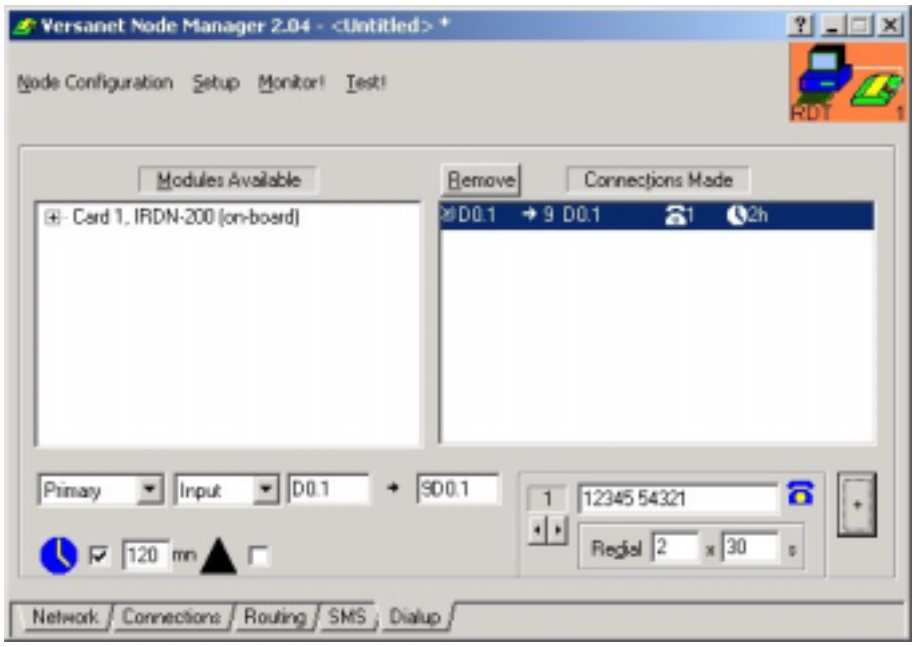
4.4.9 Dialup

Select the **Dialup** tab at the bottom of the screen.
This screen is only required if you are using a Wire Line or GSM Modem for a Dialup connection.

The 'Modules Available' is the same as the Connection screen. Modules can be expanded to show all available I/O.

The Dialup feature is programmed basically in the same way as the standard connection screen except that the transmission is via a telephone rather than uhf radio, so the destination telephone number must be specified for each connection.

a. Entering a Connection



Screenshot 20 Primary Input

In the first box make sure 'Primary' is selected.
As with the Connection screen, either select an input or output from the Modules Available list or type the information directly into the input boxes.
In the fourth box enter the destination Node and Address

Note: The final destination may be the Node at the other end of the modem link (Node 6 in the example below) in which case enter the Node number for that Node, e.g. 6D0.1
Node 6 can however act as a repeater and forward the message to other Nodes in the Network. In this case enter the final destination Node number in the destination box.

Example:
Assume we wish to programme D0.1 on Node 5 to go to D0.1 on Node 9
Enter 9D.01 in the destination box.
Node 5 will dialup and send the message to Node 6
Node 6 will act as a repeater and send the message to Node 9

Note: Node 6 will need to have the routing information programmed into its routing table.

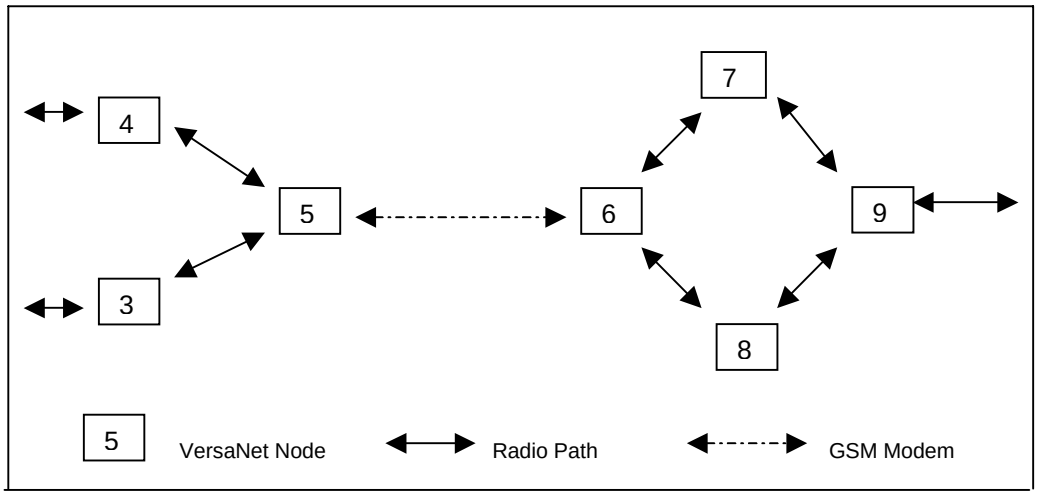


Figure 8 Example of Dial Up Routing

Once the connection details and destination are entered specify the conditions for sending the message using the boxes in the bottom left of the screen.
If you want to send the connection at a specific time interval (TX interval) check the box next to the clock icon. In the second box enter the time interval in minutes.

If you want to send the connection on event, check the box next to the triangle icon. In the second box enter specify the event that triggers the transmission:-

For analogue this is the % of FSD up or down
For pulse it is the number of pulses required to trigger a transmission.

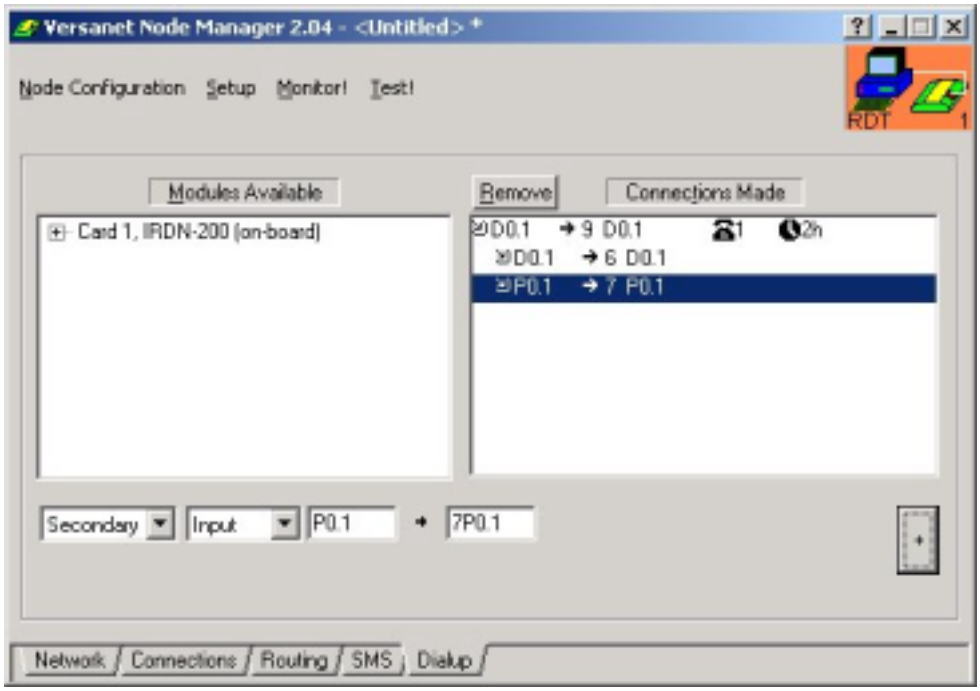
b. Secondary Connections

This is a very useful feature that allows the status of a number of I/O to be sent at the same time using only 1 telephone call.

First enter the Primary Connection. This will be the trigger condition to make the dialup connection. You can then add other I/O as Secondary messages to be sent at the same time, obviously to the same telephone number.

Example:
Node 5 (in the previous diagram, Fig 9) is the originating Node.
A Primary connection is programmed to send if D0.1 changes: D0.1 to 9D0.1
Secondary connections are added to send D0.1 to 6D0.1 and P0.1 to 7P0.1.

When D0.1 on Node 5 changes the Node will dialup and send all 3 connections. The screen will look like the above example. Note: the Secondary connections are indented on the connection list. When entering the Secondary connections some of the boxes are greyed out, TX time, Event and Telephone number, because they are only relevant to the Primary connection.



Screenshot 21 Secondary Connection

c. Telephone Numbers

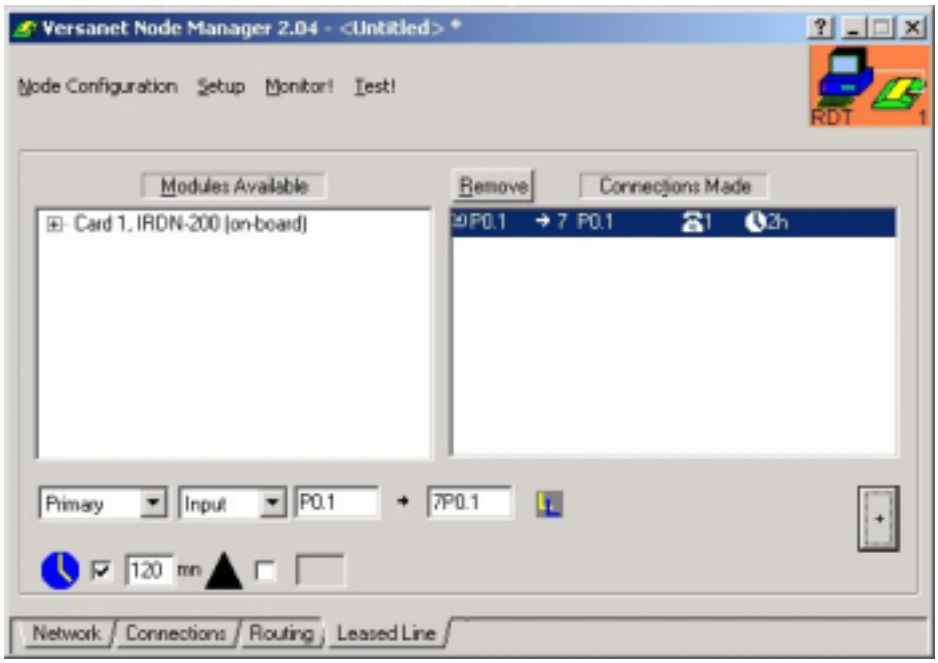
Once the connection details have been completed, enter the required telephone number in the box. Under the telephone number enter the required number of redials and the spacing. If the first attempt fails, the Node will redial the specified number of times at the set interval.

Each telephone number has an index number associated with it for reference. These telephone numbers are stored on a list, which is used by the routing screen and the dial up screen. In other words telephone number 3 will be the same on both screens, change it on one and it changes on the other. You can scroll through the numbers using the arrow keys. Up to 32 numbers may be entered.

When the connection details and the associated telephone number have been entered, press the ‘Add’ button and the information will be transferred to the Connection list. A connection can be removed by highlighting it and pressing the ‘Remove’ button.

4.4.10 Leased Line Modems

Select the Leased Line tab at he bottom of the screen. Note; this tab will only be available if the leased line modem option is selected on the Network screen.



Screenshot 22 Leased Line Modem

The leased line screen works exactly as described above for the dialup modem except of course no telephone numbers are required. Leased line modems can only operate point to point, although the receiving Node can act as a repeater and forward the data to any other Node in the network, in the normal way.

4.4.11 Downloading New Parameters

Once all the new parameters have been entered in the various sections of VNMGR, they must be downloaded to the Node.

The first step, which is optional, is to check that the data is entered correctly, i.e. that no parameters are set outside of acceptable limits and that all mandatory fields have been completed. From the Node Configuration drop down menu select 'Verify'. If all details are OK a confirmation message will appear. If not, an error message indicating the fault will be displayed. If so, correct the fault and repeat the 'verify' operation.

From the Node Configuration drop down menu select 'Send to Node'. If there is any problem with the parameters, an error message will be displayed. Correct any faults and try again.
Watch the icon at the top right of the screen. Red dots will travel from the PC to the Node icon throughout the download process. Under the icon, information about the status of download will be displayed. Finally, after the download is complete, the new network name and Node number will be displayed under the icon.

It is now advisable to power the Node down and back up again to ensure correct initialisation of the Node with the new parameters.

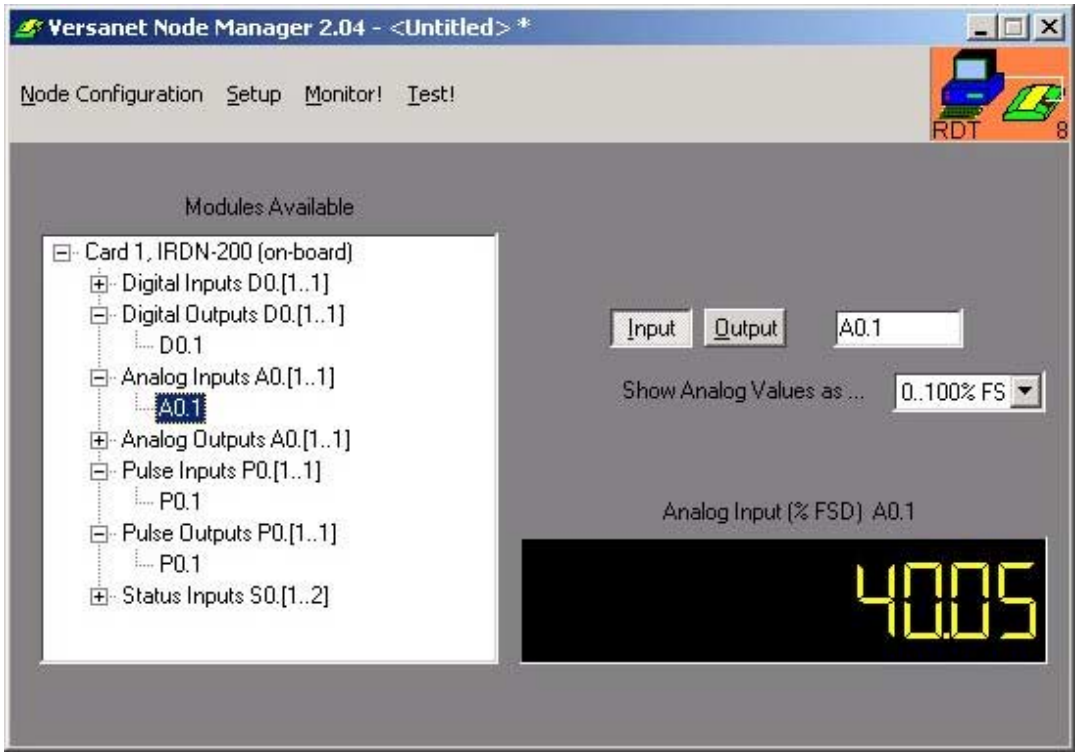
The Node is now operational.

4.4.12 Monitoring and Maintenance

The VNMGR software incorporates a monitoring section which aids system installation and maintenance. It permits the user to display the value of any piece of data either entering or exiting that Node (i.e local I/O).

Using the monitoring function **does not** suspend the normal operation of a VersaNet2 Node.

After selecting the Monitor option from the main menu, the following screen is displayed:-



Screenshot 22 Monitor Screen

The screen area labeled 'Modules Available' displays an expandable tree view of cards available. Selecting one of the Card entries from the 'Modules Available' area expands the view to display the current Input and/or Output channels on that Module. Subsequently selecting a particular channel immediately instructs the monitoring software to read the input/output channel continuously and display the current value within the 'Channel Status' box on screen. In the screen shown above, an analogue input, A0.1 is being monitored. It is set to show a percentage of FSD which in this case is 40.05%.

For Digital channels the status will be shown as 0 (off) or 1 (on). For Pulse channels the status will display the current Pulse Count.

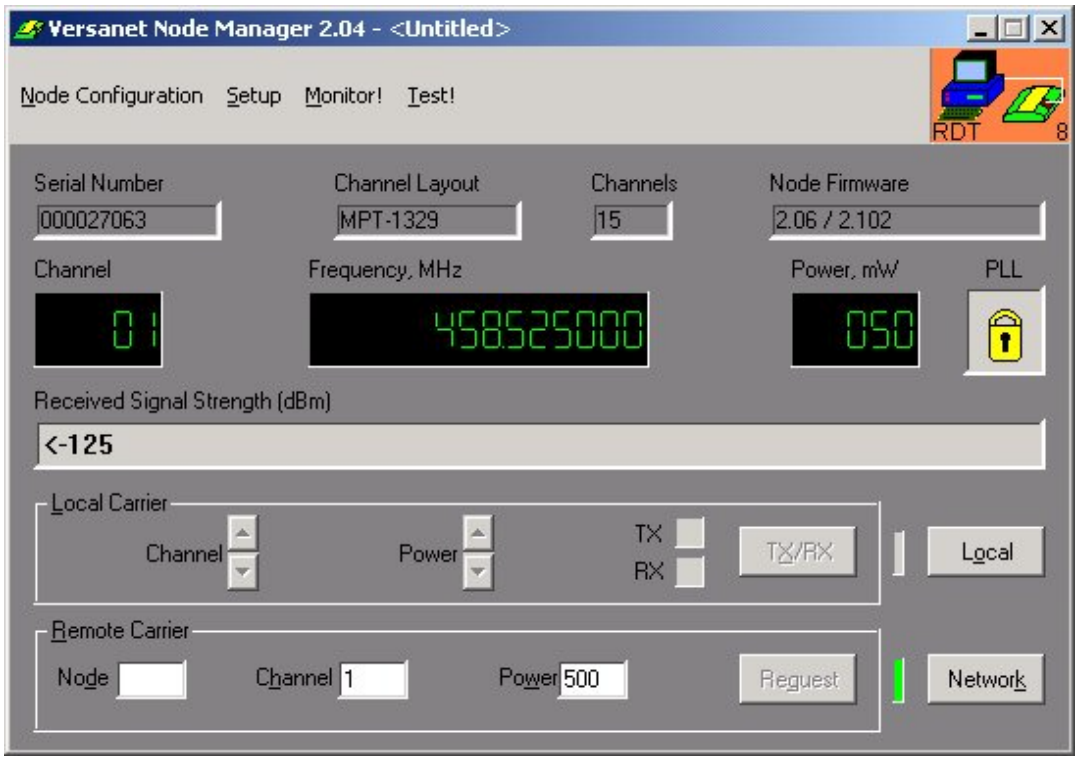
The status of all the Digital I/O of a module can be seen by selecting the card as opposed to the individual I/O channel. This will be displayed in the form '10011101', where '1' is on and '0' is off.

Alternatively, an input or output address may be typed directly into the box to the right of the buttons marked 'Input' and 'Output'. This is particularly useful where 'Virtual' addresses are used in a Node employing MODBUS to communicate to a SCADA system.

For Analogue channels it is possible to select how the status is displayed by selecting the on-screen drop down box 'Show Analog Value as..' and selecting an option from the available list.

4.4.13 Test

VNMGR is equipped with a Test facility which allows the user to conduct various tests, which aid the commissioning process.
Selecting the Test option from the main menu displays the following screen :-



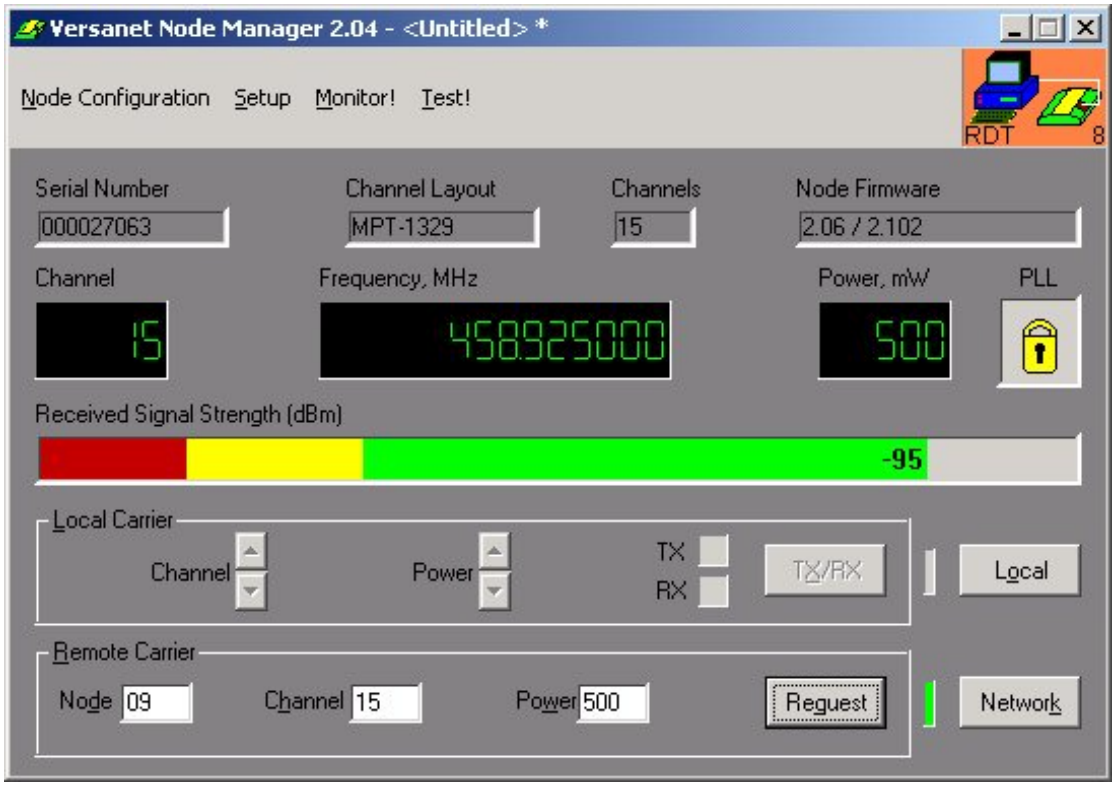
Screenshot 23 Test Screen

On entry to the Test screen, all static data is uploaded from the radio module. Static data includes Serial Number, Channel Layout and Number of Channels. This data is displayed constantly while the Node is connected to the PC. You can also see the version of software currently running.

Local/Network Mode

Two modes of operation exist within the Test facility, **Network** and **Local.**
With Network selected, it is possible to instruct a Remote Node, within radio range, to send you approximately 30 seconds of RF Carrier. This will be displayed on-screen in the form of a coloured sliding scale in the Received Signal Strength box. You can select the Node number to receive from, set its channel and power.
Using the Network mode **does not** suspend the normal operation of a VersaNet2 Node however, whilst the remote Node is transmitting the test signal, other Nodes in

the network may experience radio interference, which may prevent them transmitting (listen before transmit).
For information on the signal strength indication, see Section 6.



Screenshot 24 Test Screen Showing RSSI

Local mode allows the user to 'toggle' between Transmit and Receive manually.

In Local mode the channel and output power can be selected. In Receive mode, each channel can be monitored for activity using the RSSI sliding scale with a suitable free channel selected. Transmit mode allows the user to measure output power and check antenna matching.
As a safety precaution, the Node will revert from Local back to Network mode after 30 seconds of inactivity. All original Network parameters are restored when reverting back.
It should be noted that accessing the Local mode **suspends** the normal operation of a VersaNet2 Node.

For full details of how to use the Test facilities refer to Section 6, Commissioning.

Section 5 Installation

The installation of a VersaNet2 Node can be split into three main areas. The first covers the physical siting and installation of the enclosure, the second the siting of the antenna system and the third covers all the necessary terminations.

5.1 Hardware Installation

If the Node is to be mounted in a protected location, such as a control panel, then the module stack can be mounted directly without the IP67 Enclosure. For exposed locations an IP67 Enclosure must be used to protect the modules from ingress of dust and moisture.

A Node constructed from single or multiple enclosures may be installed with or without the modules fitted. In fact, an assembled stack of modules complete with metal base may be completely removed from an enclosure by unscrewing the four large bolts located at the four corners of the base plate. This may facilitate enclosure handling during installation.

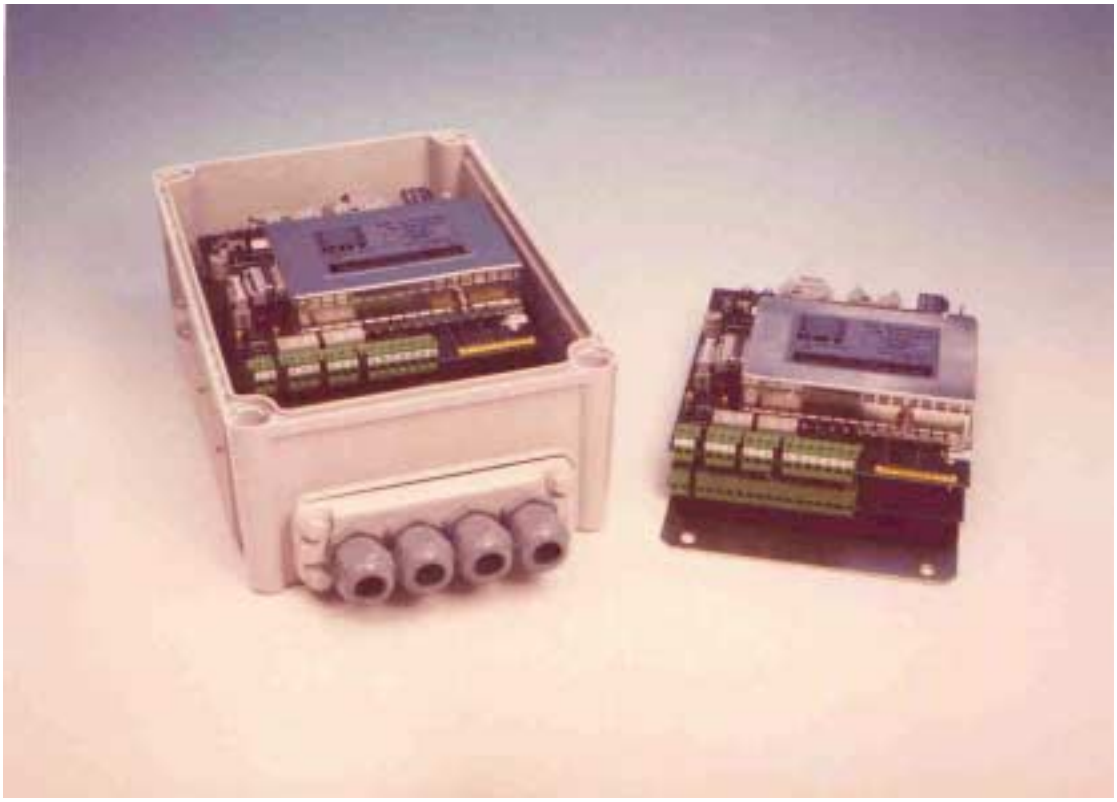


Figure 9 Node Construction

5.1.1 Choice of Location

The location of a Node will depend upon its application, although it is suggested the following guide-lines are considered.

- Avoid locating near to High Tension electrical equipment or to machinery likely to generate excessive electrical noise.

- Avoid locating near to existing radio equipment.
- Choose a location that minimises cable runs, particularly the RF cable.
- Avoid extremes of temperature, humidity and vibration.
- Locate in a convenient position for making terminations and accessing the Node for future re-configuration or monitoring purposes.
- A Node may be mounted in any physical orientation, although upright against a flat, vertical surface is the most practical.
- Ensure sufficient clearance is allowed for cables, particularly considering any bending radius restrictions.

5.1.2 Fixing Method

Four mounting holes are provided outside the sealed area for fixing to the chosen surface, spaced as shown in Fig. 10. Bolts or screws of M6 x 40mm or equivalent should be used. When installing multiple enclosure Nodes, use a fixing bolt through all mounting holes to achieve maximum physical stability. Alternatively, a Node may be mounted onto a pole or other structure using simple metal braces. Nodes may also be secured inside outer cabinets or marshalling kiosks to suit the application.

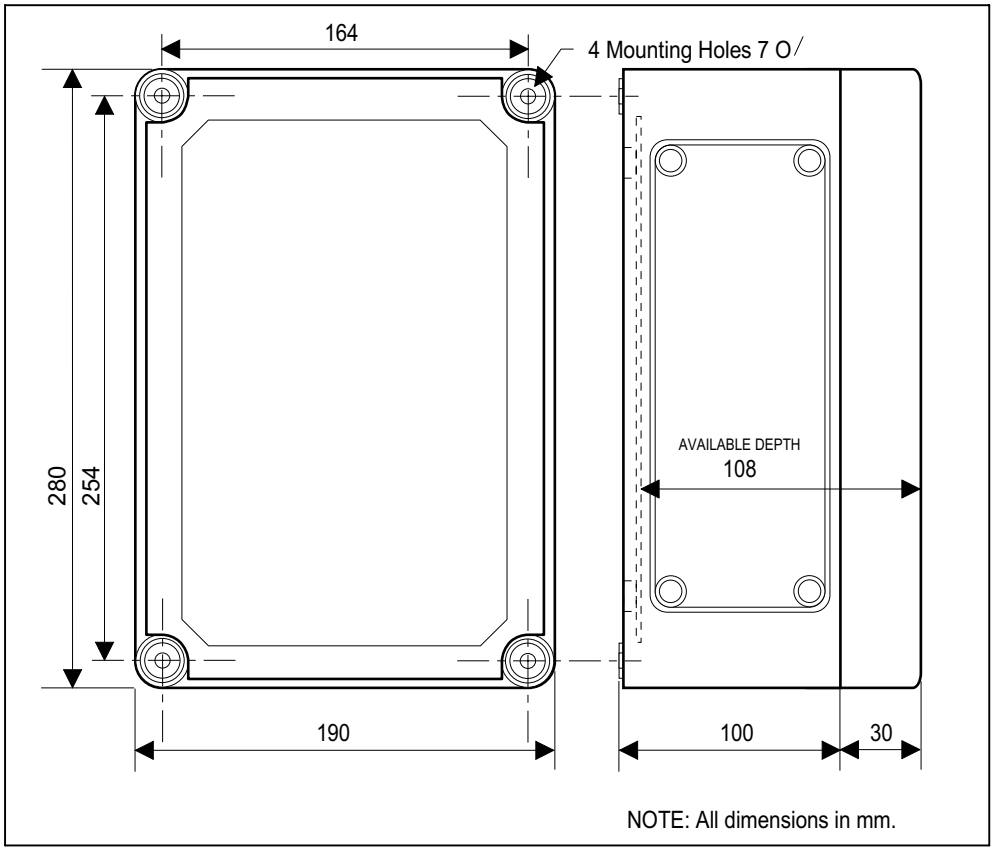


Figure 10 Mechanical Drawing of Enclosure

5.2 Antenna Installation

The performance of an antenna and hence the equipment using it, is very dependent upon the environment in which it is mounted. Although it is often

advisable to employ specialist personnel to install antenna systems, following the broad guide-lines contained in this section will result in successful installations in the majority of situations. In all cases, antennas should be vertically polarised. The precise type of antenna will have been selected during system planning, although further details may be found in Section 3.6 of this manual.

5.2.1 Choice of Location

As a general rule, the less directional the antenna, the more likely it is to be affected by the environment it is mounted in.

In practice, a Yagi antenna should be mounted with all its elements at least one wavelength (70cms) away from the supporting structure i.e., walls. This avoids excessive degradation of both the directional and gain performance of the antenna. Omni directional antennas such as dipoles and collinear arrays only achieve genuine omni directional performance when mounted at the top of its supporting structure.

When deciding upon the location of an antenna, consideration should be given to the effect of the surrounding land on the radio signal. In general, Nodes should be located so that their antennas are in line-of-sight of each other. Following this guideline will result in reliable signal paths up to about 20 km for 500 mW ERP in the majority of situations.

An additional factor in radio propagation is the effect of multiple signal paths between sites, often caused by reflections off buildings, water or other fixed objects. This can cause a dramatic reduction in received signal strength due to phase cancellation, but can be cured easily by moving the receiving antenna about 0.3m (half a wavelength).

Temporary fading of the received signal can also occur due to reflections off moving vehicles again due to multiple paths. This phenomenon is less important in fixed link data networks, as its effect is only momentary and VersaNet's retry algorithm will offset this problem.

Also, an antenna mounted just below the brow of a hill should theoretically receive very little signal. In practice, however, it is likely that such an antenna would receive a reasonable signal due to the bending of the wave front over the hill by diffraction.
The antenna should be mounted as far away as possible from another antenna. If this is unavoidable, the antennas must be mounted at different levels.

Section 5 of the manual covers the procedure for measuring the performance of the paths, but it will be assumed that the antenna location has already been decided upon. It is worth noting here, however, that increased range performance can usually be attained by raising the height of an antenna by only a few metres.

5.2.2 Antenna Cables and Connectors

It is advisable to keep the antenna feeder down to as short a length as possible to avoid unnecessary degradation of signal.

For the majority of applications, UR-M67, RG213/U or equivalent cable should be used with N-type connectors. The Antenna Bulkhead Cable Kit provides a bulkhead-mounted N-type female enabling an antenna feeder cable to be connected. Fitting RF connectors to RF cable is a specialist task and should only be carried out by trained personnel. Alternatively, a number of organisations, particularly antenna suppliers, offer a cost-effective cable making service. **A poorly fitted connector can seriously impair the operation of a radio system**.

All exposed metal connectors should be protected from the ingress of moisture by using non-setting sealing pastes, self-amalgamating tapes or by using the PVC boots or drip-covers often supplied already fitted to antennas.

Where particularly long antenna feeders cannot be avoided, or if the feeders may be adjacent to other higher power radio-systems, semi-rigid or double-screened cables should be used. It is also advisable to ensure that if antenna feeders must cross each other, they do so at right-angles to reduce any coupling.

5.2.3 Lightning Protection

Antenna systems can be particularly prone to lightning strikes due to their generally exposed location and relatively high structures. It is not possible to completely remove the possibility of a lightning strike although a number of sensible precautions may be taken to reduce the risk and minimise any damage caused in the event of a strike.

Antenna supply and installation organisations will have specific experience with regard to lightning protection and should be consulted where possible. Additionally, the relevant British Standard (BS6651:1985) Code of Practice for the Protection of Structures Against Lightning, may be consulted. By following the guide-lines contained here, the risk can be minimised.

The overall aims are to provide the shortest, most direct path to earth for the lightning current, to ensure good bonding between all site metalwork and the earthing system to reduce side flashing, and to avoid the entry of flashes or surges into buildings. The general guide-lines include:

- All earth straps, tapes and bonding interconnections should be of uninsulated copper tape of minimum cross section 25 x 3mm

- All connections, clamps and supports should be protected by non-reactive paste or tape.

- Ground mounted support structures should be connected at their base to an earth ring arrangement by the method described.

- Roof mounted structures should be connected to the building earth by the most direct route possible.

- Mast guy wires should be directly bonded to earth at their lowest point.
- Antenna feeders should be bonded to the supporting structure at the upper and lower ends and earthed at the point of entry into the building. Surge arresters may be fitted at this point, although they will not prevent damage arising from a direct strike.

- Associated plant, pipes, fences or gantries and other metalwork within about 3 metres of the support structure should be bonded directly to earth.

An earth ring usually consists of copper tape with driver electrodes or radial tapes around the base of the structure, as close as possible. The ring should be buried to a depth of between 0.6m and 1.0m where conditions permit. It should be connected to the main building earth by the most direct route possible, buried as appropriate.

5.3 Connecting Cables to a Node

In addition to any RF cable, power and signal connections will also need to be made to a Node. There connections are made via the two-part terminals fitted to all VersaNet2 modules.

Cables of up to 2.5mm cross sectional area may be used in the connectors. Cables are passed up through the nearest cable glands and inserted into the correct terminal using a small flat-bladed screwdriver. The terminals are designed to be removed from the module-mounted section to allow easy connection. Where possible, avoid armoured cable directly entering a Node as this will make manipulations more difficult.

Take particular care when making connections to 2-way connectors as damage can be caused by excess flexing of the connector. When used in an external cabinet or kiosk, connections can be made to a sequentially numbered DIN rail fitted with suitable terminals and corresponding to an approved wiring scheme.
It is suggested that a wiring scheme be drawn up prior to installation and numbered ferrules used to aid identification. The function of all the I/O and Power Supply terminals are shown in Section D of this manual and on the Module Datasheets supplied with each module.

Once connections have been made, the cable glands may be tightened to form an environmental seal, preventing the ingress of dust and moisture.

Note: Whilst precautions have been taken to make VersaNet2 a rugged product, transient dips and spikes on the power supply should be avoided, as far as possible.

Section 6 Commissioning a System

Commissioning a VersaNet2 system consists of:
checking carefully all connections;
ensuring all Nodes are correctly configured;
powering up and running the Test programme accessed via the VNMGR software supplied with each Communications Controller;
checking that all inputs are reflected correctly at their corresponding outputs on the destination Node.

Connecting the Communications Controller to your PC using the configuration lead supplied and running the VNMGR software will provide access to the Test screen where you can perform all of the commissioning routines.

On entry to the Test screen, all static data regarding the RF module is displayed along with a Received Signal Strength Indicator (RSSI) for the RF channel indicated. The RSSI display travels from left to right across the screen and consists of three colours and a numeric readout.

Signal levels at -120dBm or less are displayed in red.
Signal levels between -120dBm and -114dBm are shown in yellow.
Signal levels >-114dBm are shown in green.

6.1 Selecting a suitable RF Channel

In some countries VersaNet2 is supplied to operate on a particular RF channel that has been pre-allocated by the National Radio Authority for the country in question. If this is the case then the frequency should be free from interference by other users. Other countries, such as the UK, have a band of radio channels available that are classed as 'licence-free'. This means that anyone can operate type approved radio equipment on any of the available RF channels and care needs to be taken to avoid selection of a 'busy' radio channel that may impair the performance of the system you are commissioning. VersaNet2 uses a 'listen-before-transmit' strategy, which effectively checks the RF channel for activity prior to sending any data and minimises the chances of interference. A busy channel may therefore cause unacceptable delays.

On entry to the Test screen select the Local button, which places the Node into Local mode and permits you to monitor RSSI on all of the available RF channels in order to select an appropriate operating channel for the network. Obviously if you are adding a Node to an existing network the correct channel must be selected to match the other Nodes in the system.

Step through each of the available RF channels in turn by selecting the channel up/down arrow. After each channel change, monitor the RSSI indicator for channel activity. Make sure all other Nodes in the system are turned off or they may be seen on the indicator.

If any green segments of the display are visible, this indicates RF noise at a level that will prevent the VersaNet2 Node from transmitting.

Noise may vary from site to site so this procedure should be followed at all planned VersaNet2 locations and an RF channel should be selected that is available for use at all locations.

6.2 Checking Signal Strength between Nodes

The ‘Remote’ facility allows you to ask another VersaNet2 Node to send you approximately 30 seconds of RF carrier so that you can correctly check the received signal strength at the Node you are commissioning.

To request a remote Node to send you a test signal you must first make sure that Network is selected on the Test screen.

Next select the 'Node' box and enter the number of the remote Node that you wish to send you a test signal. Set the channel and the power. This will remotely set the channel and transmit power of the selected Node.

Finally click on the 'Request' button. The remote Node selected will now transmit RF carrier for approximately 30 seconds allowing you time to monitor the RSSI display.
To ensure reliable operation between the two Nodes selected, it is advisable that the RSSI bar graph is steadily showing a minimum of -110dBm, which is equivalent to any part of the indicator being green.

Note: Before performing the RSSI signal strength check, wait a few minutes and check that the channel is quiet. Any activity on the channel may affect your results and could prevent the selected Node from transmitting.
When the requested signal is first received, the RSSI indicator may flash up and down. This is because the Node is receiving valid data from the selected Node. Wait for this to finish then hit the request button again.
During the 30 second test period other units on the same channel may be affected.

If no RSSI display appears then check all antenna and cable connections before repeating the process.

Section 7 Technical Specifications

7.1 General

7.1.1 Mechanical

All VersaNet2 modules, except for the DC Adaptor, meet the same mechanical specifications shown in Figure 11. All except the Communications Controller are supplied with a T2-BUS cable.
In addition, mounting pillars are supplied with each module to provide adequate clearance above the module.

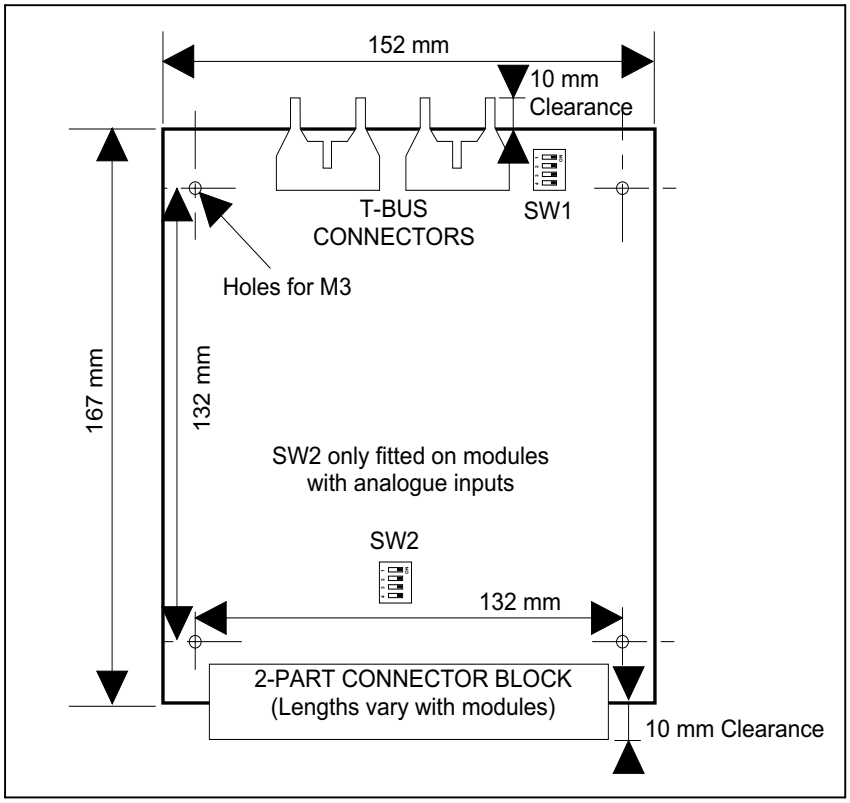


Figure 11 Mechanical Drawing of a Module

7.1.2 Environmental

VersaNet2 module are temperature rated from - 10° to + 55°C. and are designed to withstand Relative Humidity of 95%, non-condensing.

7.2 Communications Controller

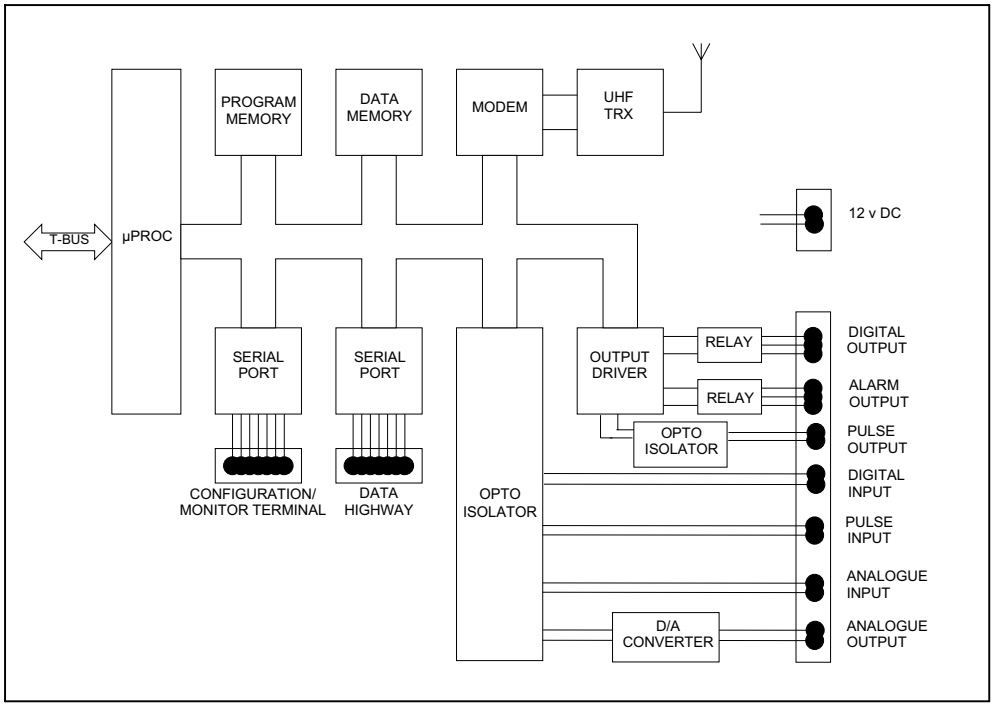


Figure 12 Communications Controller Block Diagram

This module is at the heart of every Node, containing the main micro controller circuitry, modem and UHF synthesized FM transceiver. It handles the Node management, data security, health checks and retains the Node configuration in RAM. The module also has I/O capability in the form of a digital input and output, analogue input and output, Pulse input and output, alarm output and RS232 serial data highway.

RF Section

General		Transmitter		Receiver	
Frequency Range	406-470Mhz	RF output power	1W max	Sensitivity	-110 dBm
Mode	Half duplex	Modulation	GMSK		for 10^{-4} BER
Approvals	ETS300 220	Adj. Chan. Power	<-37dBm	Spurious	>70 dB
	ETS300 113	Spurious emissions	<-36 dBm	Blocking	> 84dB
	ETS300 683	Freq. tolerance	+/- 1kHz	Intermodulation	> 70dB
		FM deviation	+/- 2 kHz	Adj. Channel	> 60 dB

Technical Specification

Module Name	Communications Controller	
Part Number	IRDN2xx (Digital I/O only)	
	IRDN2xxA (Digital + Analogue I/O)	
No. of Modules per Node	1	
Processor	Hitachi H3048	
Internal interface	2 x T2-BUS Master	
Digital Inputs	1 opto-isolated, volt free	
Digital Outputs	1 changeover relay, 8A @ 250V AC, 8A @ 30V DC	
Alarm Output	1 changeover relay, 5A @ 240V AC, 5A @ 30V DC	
Analogue Input (IRDN2xxA)	1, 0-5 V DC or 0-20mA	
Precision	12 bit	
Scan Rate	<1S	
Analogue Output (IRDN2xxA)	1, 0-20mA	
Precision	10 bit	
Load resistance	250 Ω	
Output settling time	500mS max.	
Pulse Input	1	
Input Pulse Width	5 mS min.	
Input Pulse Frequency	100 Hz max.	
Maximum Pulse Count	65535	
Scan Rate	<1S	
Pulse Output	1	
Serial Ports	1xRS232 Serial Data Highway	
	1xRS232 Configuration ASCII Port	
Power Supply	+ 11-14v DC via JP3	
Current Consumption	Sleep Mode	400µA typical
	Operating (RX)	380mA
	Operating (TX)	650mA (@500mW)
		600mA (@250mW)
		550mA (@100mW)
		520mA (@50mW)
Operating Temperature	-10^0 to $+55^0$C	
User Connection	Configuration - 9-way D male	
	Serial Data Highway - 9-way D male	
	All other 2 part screw terminals	
Dimensions	152 x 167 x 42mm	
Weight	0.6kg	

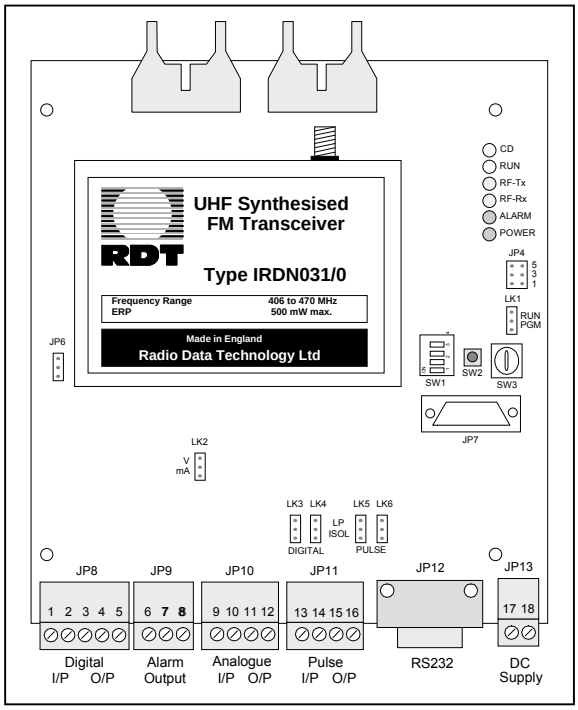


Figure 13 Communications Controller

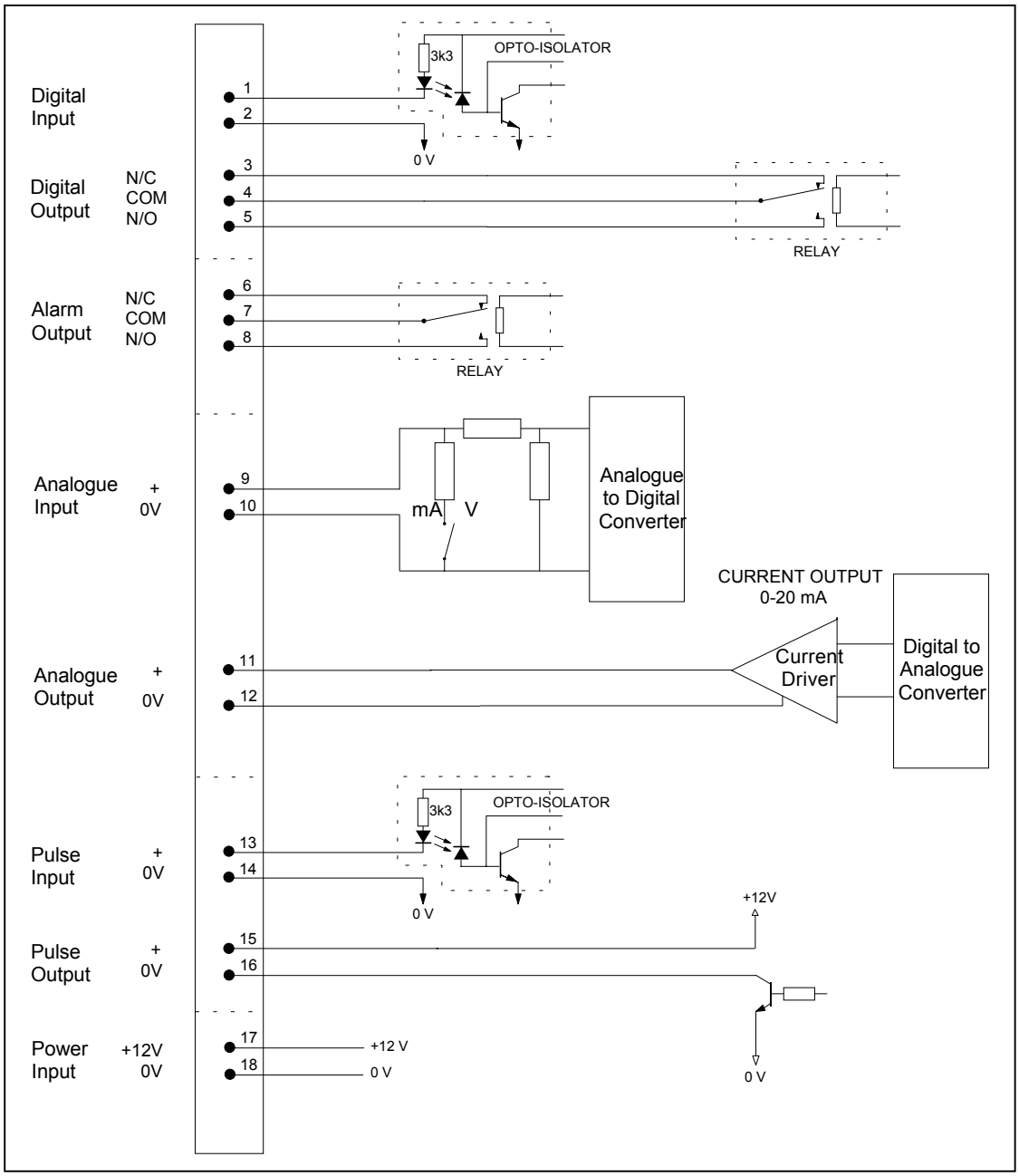


Figure 14 Communications Controller Connection Chart

7.2 Digital Output Module – IRDN201

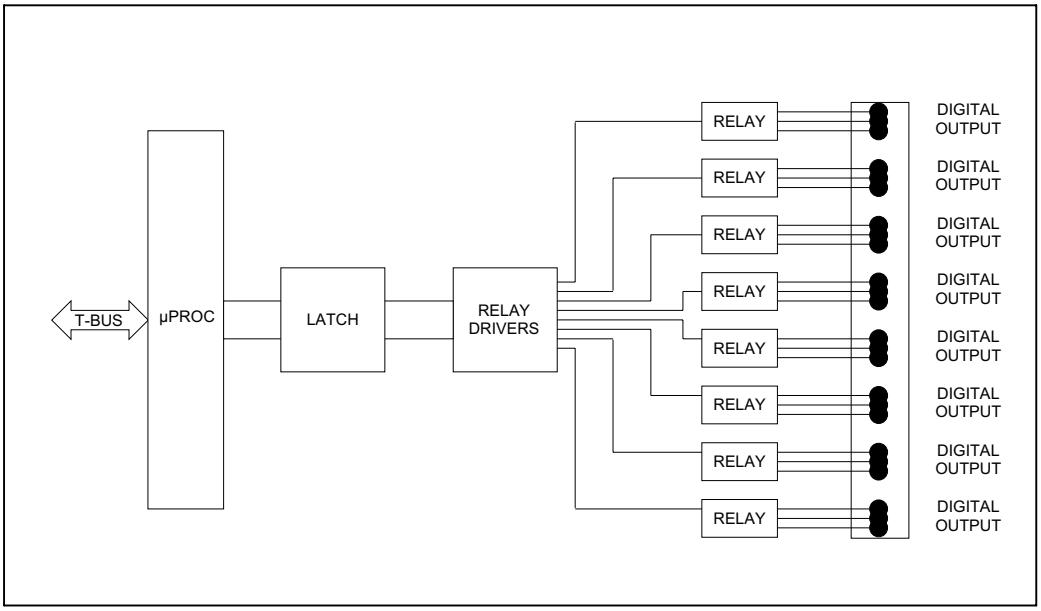


Figure 15 Digital Output Module Block Diagram

This module provides eight digital outputs to external devices via changeover relays. Up to sixteen modules may be used in a single Node.

Technical Specification

Module Name	Digital Output
Part Number	IRDN201
No. of modules per Node	16 max
Processor	80C31
Internal Interface	T2-BUS Slave Peripheral
Relay Outputs	8 Latching changeover
Loading	min 1mA @ 1V DC max 8A @ 240V AC 8A @ 120V AC 8A @ 30V DC
Output settling time	20 ms per channel from receipt of T-Bus command
Contact life expectancy (mechanical)	1 x 10^7 operations
Power Supply	11-14V DC through T2-BUS
Current Consumption	min 30 mA type 130 mA max 250 mA
Operating temperature	-10°C to +55°C
User connection	2 part screw terminals
Dimensions	152 x 167 x 32 mm
Weight	0.3kg

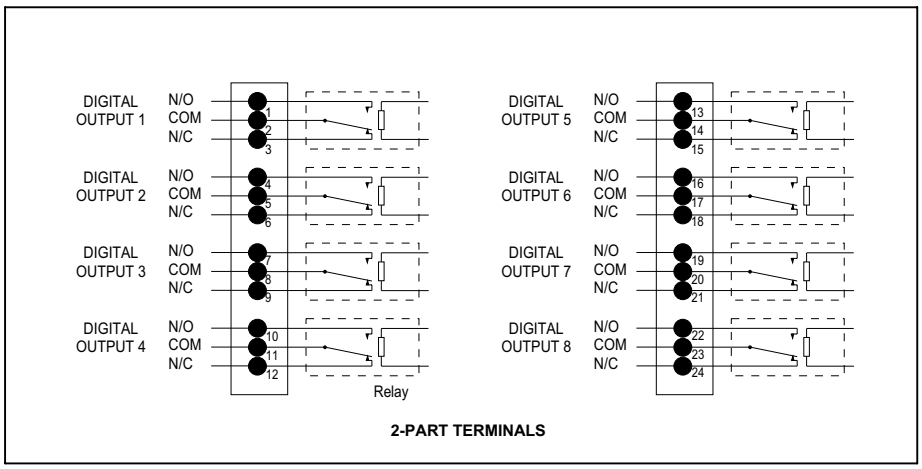


Figure 16 Digital Output Module Connection Chart

7.4 Digital / Pulse Input Module – IRDN202

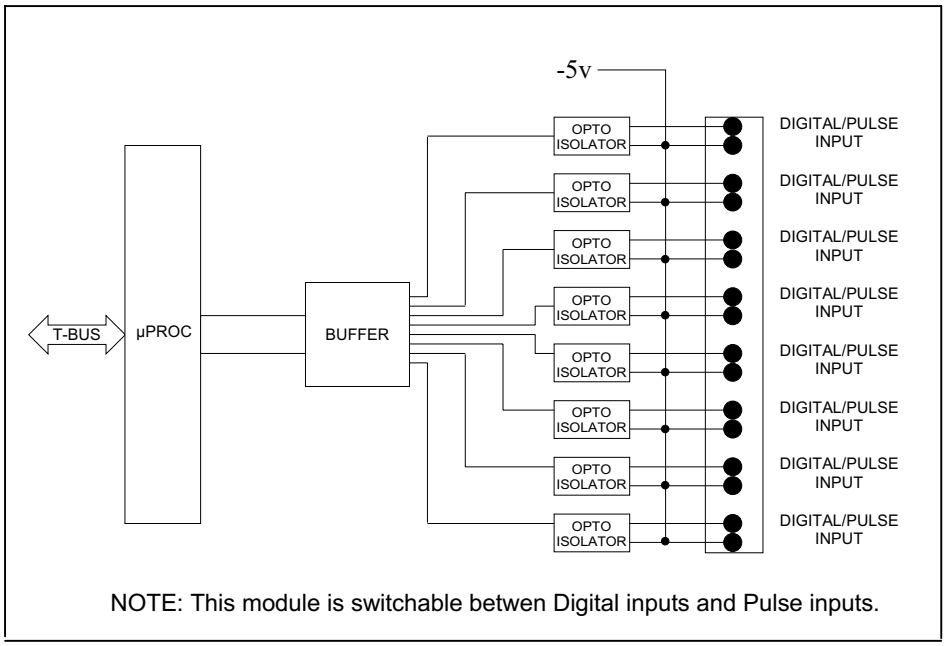


Figure 17 Digital / Pulse Input Module Block Diagram

This module is used to collect eight channels of either volt free digital contacts or pulse counting inputs into a VersaNet2 Node. Each individual channel on the module mat be configured as a Pulse or Digital input, giving the module a dual function. A maximum of sixteen modules may be used in one Node with any combination of digitals and pulses.

Each input channel consists of an opto-isolated input (+ve) and a common negative (-5v) for connection to the users volt free contacts or open collector transistor outputs.

When used for pulse counting, only pulses wider than 5mS will be detected. Each input channel has a counter capable of storing a maximum count of 65535. The user must ensure that an appropriate transmission interval is selected to avoid counter overflow, between transmissions as no indication of such an overflow is provided.

Technical specifications

Module Name	Digital/Pulse Input
Part Number	IRDN202
No. of modules per Node	16 max.
Processor	80C31
Internal Interface	T2-BUS Slave Peripheral
Input Channels	8 (Programmable for Digital or Pulse)
Input terminal voltage	+/- 5 V DC
Input Pulse Width	5 mS min.
Input Pulse Frequency	100 Hz max.
Maximum Pulse Count	65535
Scan Rate (Digital i/ps)	1 second
Power Supply	11-14V DC through T2-BUS
Current Consumption	min. 30 mA typ. 50 mA max. 70 mA
Operating Temperature	-20° to + 70°
User Connections	2 part screw terminals
Dimensions	152 x 167 x 22 mm
Weight	0.2kg

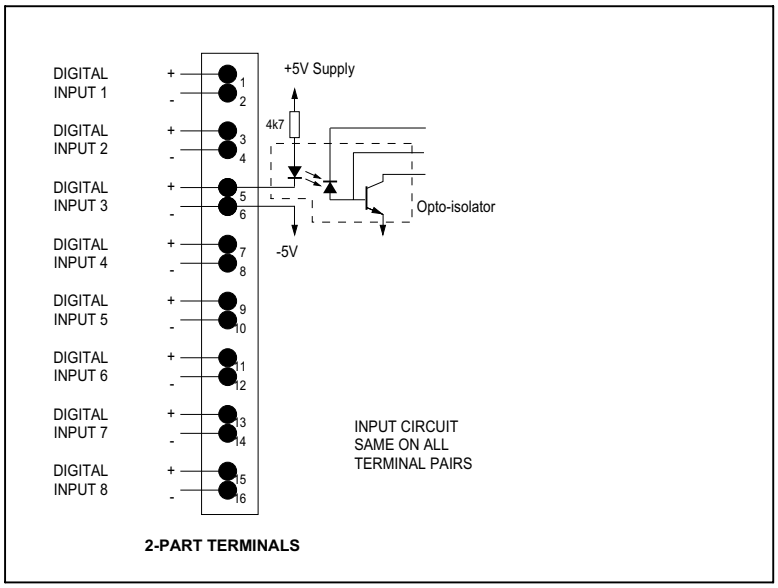


Figure 18 Digital / Pulse Input Module Connection Chart

7.5 Combination Input Module – IRDN203

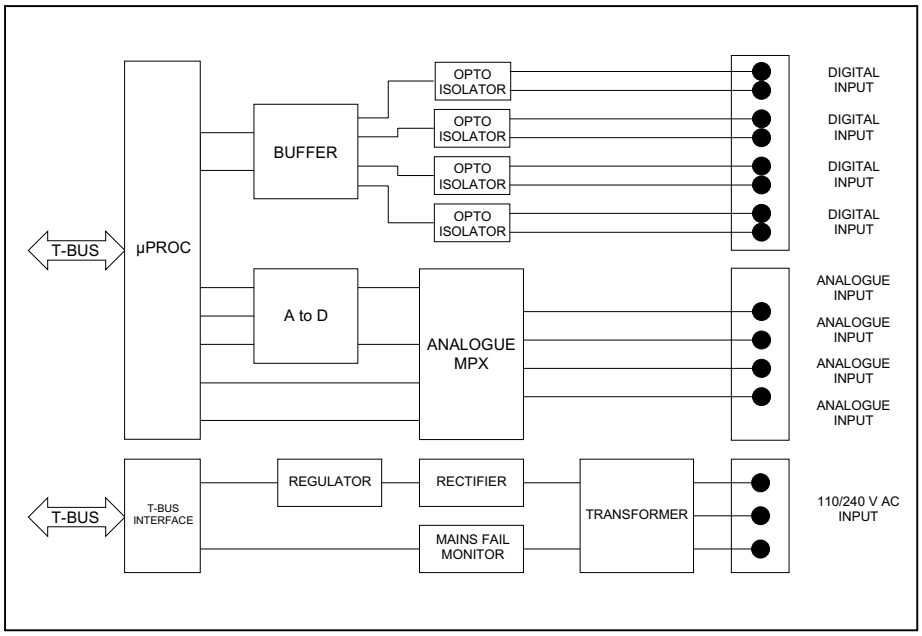


Figure 19 Combination Input Module Block Diagram

This module is used to collect up to four digital steady-state inputs and four DC analogue channels. The analogues may be either 0-5V DC or 0-20mA, switchable for each channel individually. The module also incorporates an on-board mains power supply which is capable of supplying up to 800mA to a Node. Due to addressing restrictions only one module is permitted per Node.

Each Digital input channel consists of an opto-isolated input (+ve) and a common negative (-5v) for connection to the users volt free contacts or open collector transistor outputs. Note that the analogue inputs are not isolated.

Technical Specifications

Module Name	Combination Input
Part Number	IRDN203
No. of modules in a Node	1 maximum
Processor	80C32
Internal Interface	T2-BUS Slave Peripheral
Digital Inputs	4 Volt free
Analogue Inputs	4 channels 0-5V DC or 0-20mA DC switchable
Precision	12 bit
Scan rate	1 second for all channels
Power Supply	110V AC/240V AC ± 10% (switchable)
Current Consumption	50 mA typ.
Operating Temperature	-20°C to +70°
User Connection	2 part screw terminals
Dimensions	152 x 167 x 32mm
Weight	0.6kg

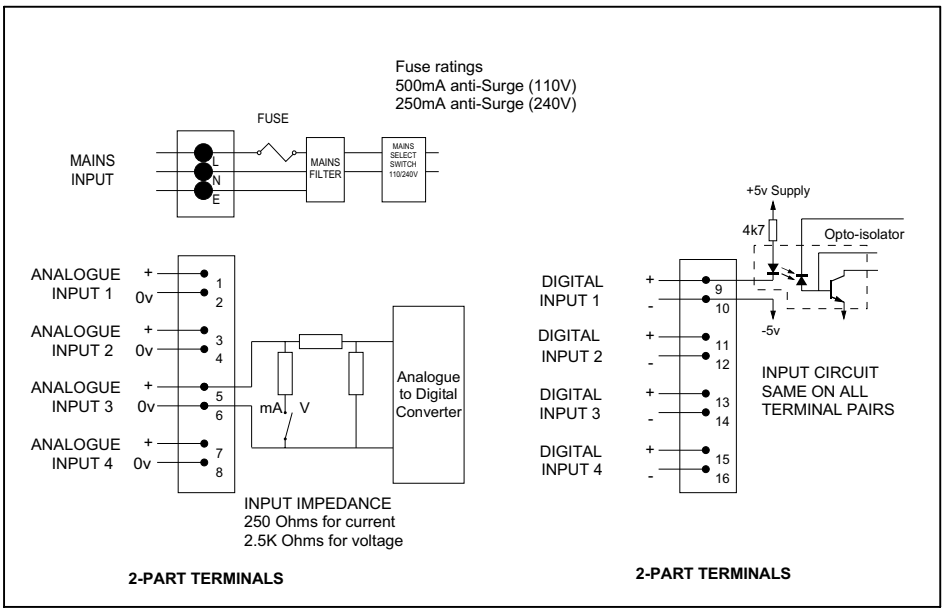


Figure 20 Combination Input Module Connection Chart

7.6 DC Adaptor Module – IRDN206

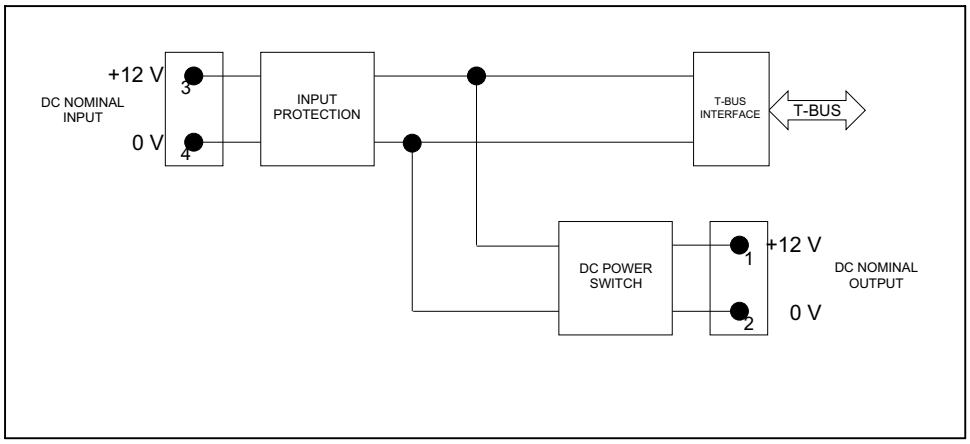


Figure 21 DC Adaptor Module Block Diagram

This module is used to allow connection of a second power supply to the T2-BUS of a VersaNet2 Node. Each module can handle up to 3A input power and a maximum of 2 modules may be used in a single Node.

This module may be mounted over the front or rear pillars of a module stack using the long T2-BUS cable supplied. The module can also be used to supply up to 250mA @ 12V DC to an external device controlled via the Communication Controller.

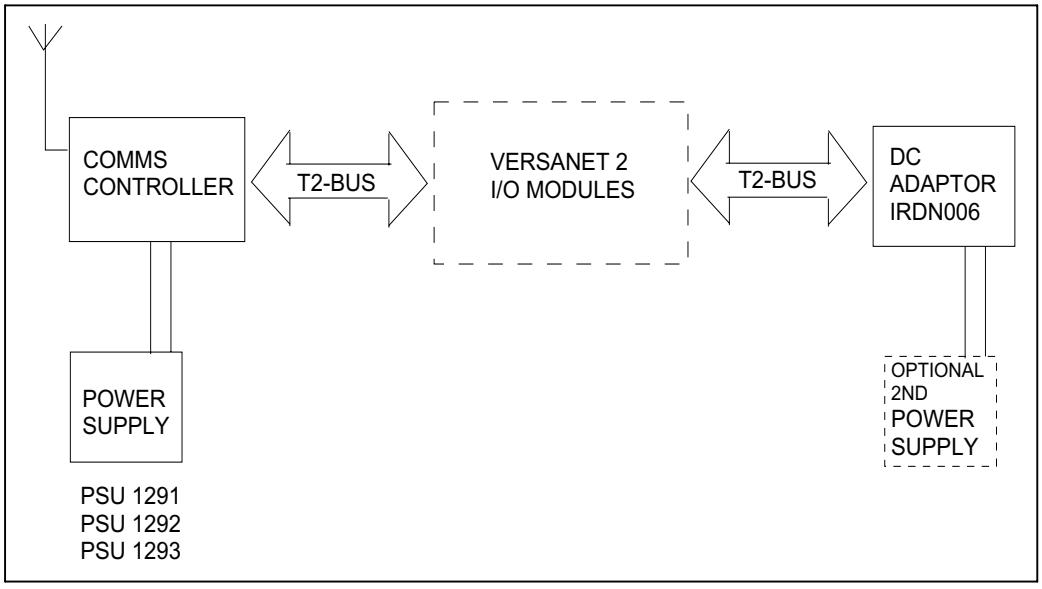


Figure 22 Additional Power Supply Connection

Technical Specification

Module Name	DC Adaptor
Part Number	IRDN206
No. of modules in a Node	2 maximum
Internal Interface	T2-BUS peripheral
Input Voltage	11-14DC, max 3A
Output voltage to external device	12V DC nominal, max 250mA
Input Protection	Reverse polarity protected
Output voltage on-time	Programmable via Communications Controller
Operating Temperature	-20°C to +70°C
User Connection	2-part screw terminals
Dimensions	152 x 42 x 32mm
Weight	0.1kg

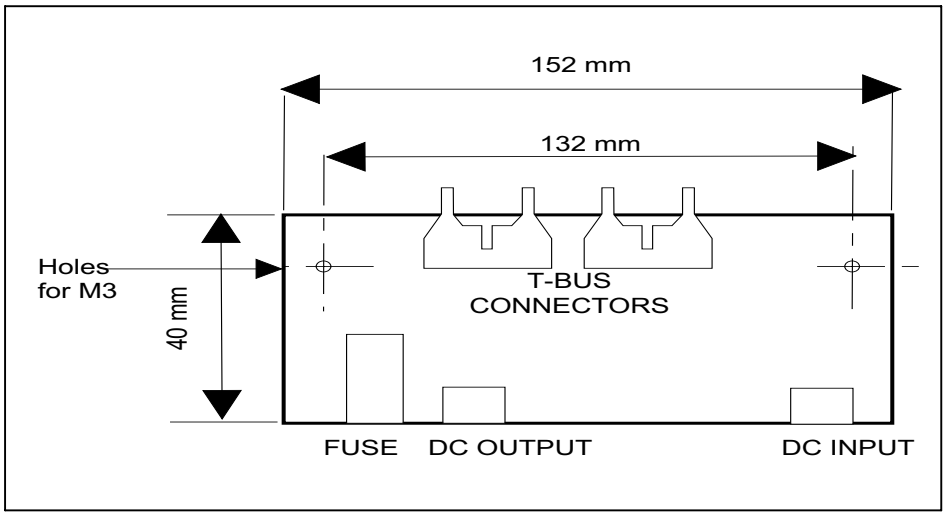


Figure 23 Mechanical Drawing of DC Adaptor Module

7.7 Analogue Input Module – IRDN207

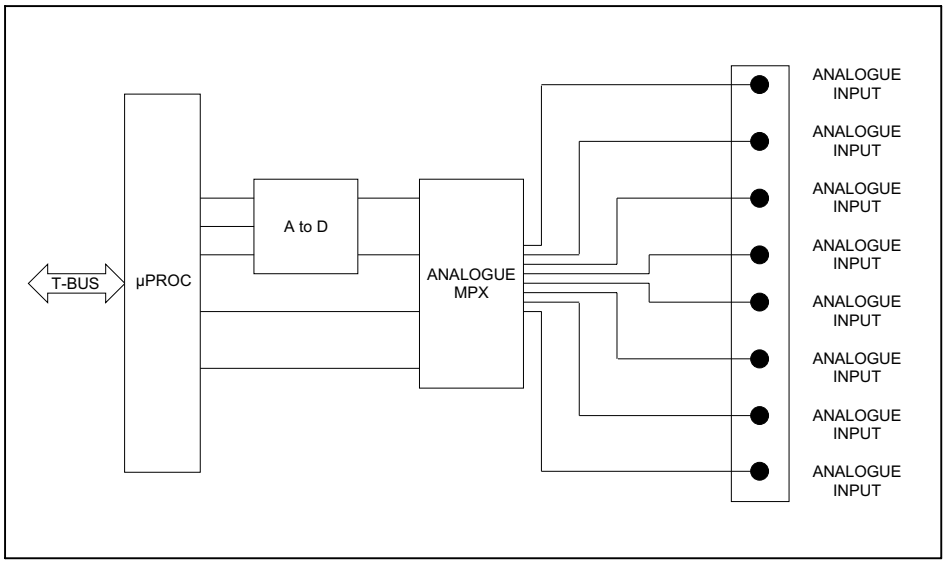


Figure 24 Analogue Input Module Block Diagram

This module is used to collect up to eight analogue readings into a Node. The data may be in the form of DC voltage in the range of 0-5V or a DC current of 0-20mA. This is switchable for each input channel individually. Up to sixteen of these modules may be used in a single Node.

The use of external isolators is recommended.

Technical Specifications

Module Name	Analogue Input
Part Number	IRDN207
No. of modules per Node	16 max
Processor	80C32
Internal Interface	T2-BUS Slave Peripheral
Analogue Inputs	8 0-5 V DC or 0-20mA DC suitable
Precision	12 bit
Scan Rate	1 second for 8 channels
Power Supply	11-14V DC through T2-BUS
Current Consumption	min 10mA type 50mA max 100mA
Operating temperature	-20° to +70°
User connection	2 part screw terminals
Dimensions	152 x 167 x 22 mm
Weight	0.2 kg

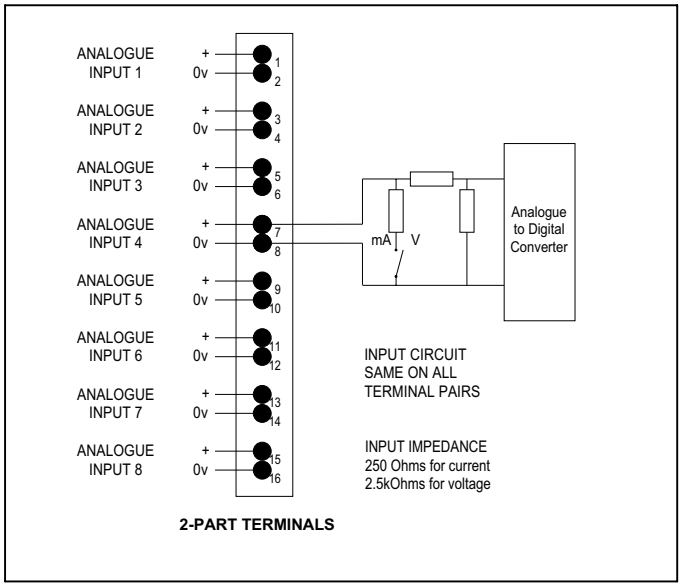


Figure 25 Analogue Input Module Connection Chart

7.8 Analogue Output Module – IRDN208

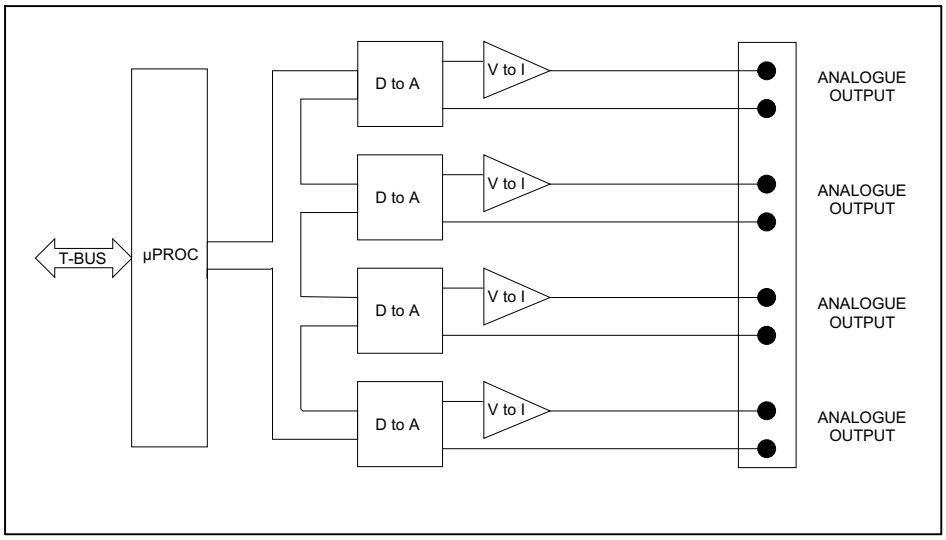


Figure 26 Analogue Output Module Block Diagram

This module provides four channels of DC analogue output for connection to external devices. The signals are in the form of DC currents between 0-20mA. A DC voltage output may be obtained by adding external precision resistors to each channel. Up to sixteen of these modules may be used in a single Node.
Note: Analogue outputs do not require an external loop power supply.

Technical Specifications

Module Name	Analogue Output
Part Number	IRDN208
No. of modules per Node	16 max
Processor	80C31
Internal Interface	T2-BUS Slave Peripheral
Analogue Outputs	4 x 0-20mA current devices
Precision	12 bit
Load resistance	250 Ω
Output settling time	500mS maximum from receipt of T2-BUS command
Power supply	11-14V DC via T2-BUS
Current Consumption	min 15mA type 50mA max 120mA
Operating temperature	-20°C to +70°C
User connectors	2 part screw terminals
Dimensions	152 x 167 x 22mm
Weight	0.2k

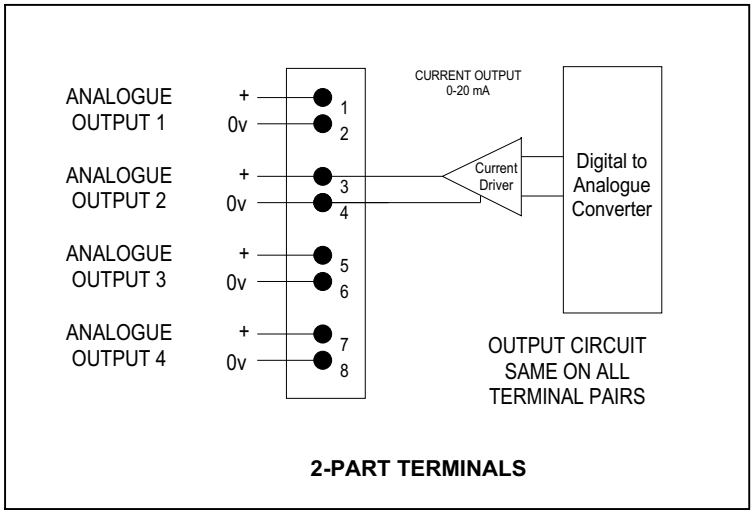


Figure 27 Analogue Output Module Connection Chart

7.9 Pulse Output Module – IRDN209

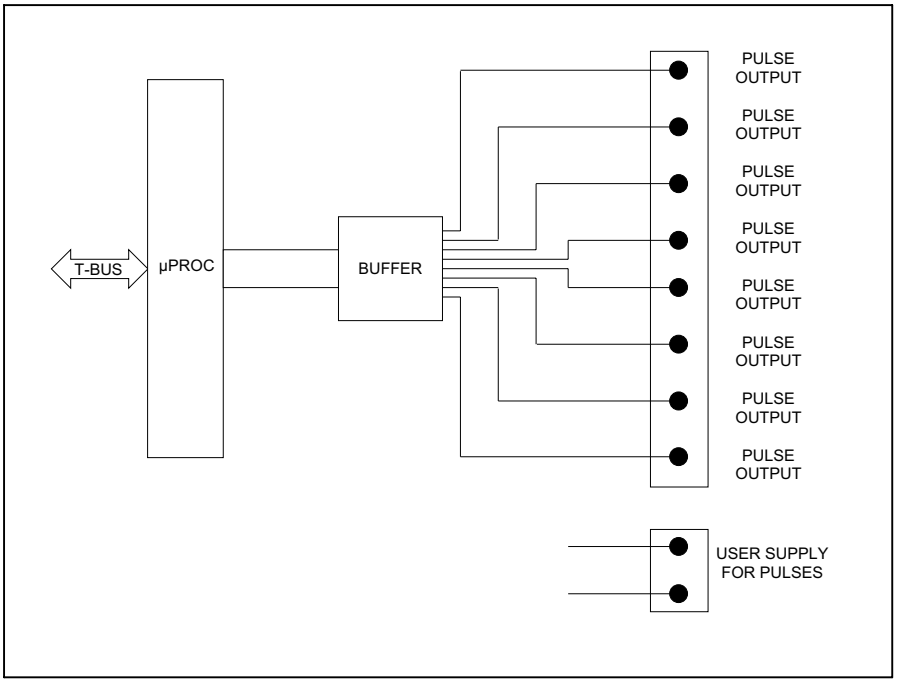


Figure 28 Pulse Output Module Block Diagram

This module provides eight solid state outputs generating pulse signals. Up to sixteen of these modules may be used in a single Node.

The outputs are compatible with most types of pulse counters requiring an input pulse width of greater than 50 mS. The user should use scalers at the pulse inputs to ensure the outputs react fast enough.

Technical Specifications

Module Name	Pulse Output
Part Number	IRDN209
No. of modules per Node	16 max
Processor	80C31
Internal Interface	T2-BUS slave peripheral
Solid State Outputs	8 Open collector Max switching current 500mA Max switching voltage 60v
Pulse Outputs	17 Hz
Pulse Width	50mSec min.
Power supply	11-14V DC through T2-BUS
Current Consumption	min 10mA type 50mA max 75mA
Operating temperature	-20°C to +70°C
User connection	2 part screw terminals
Dimensions	152 x 167 x 22mm
Weight	0.2kg

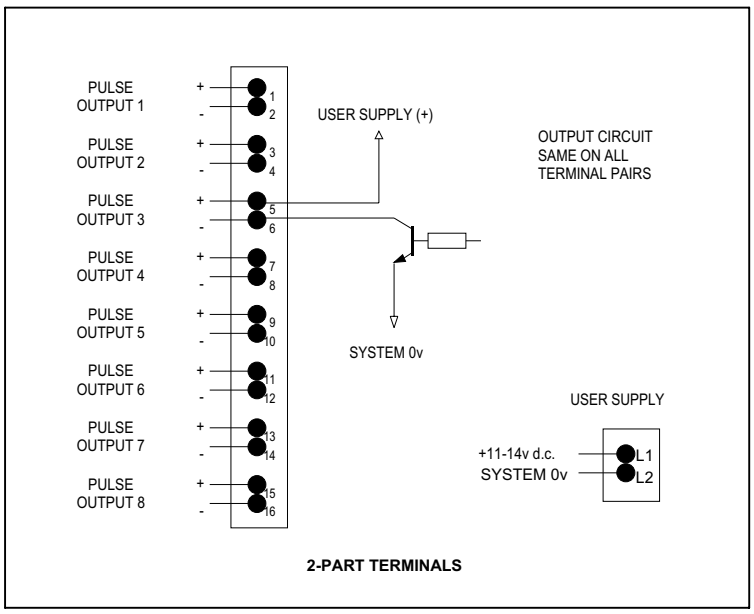


Figure 29 Pulse Output Module Connection Chart

7.10 Combination Output Module – IRDN210

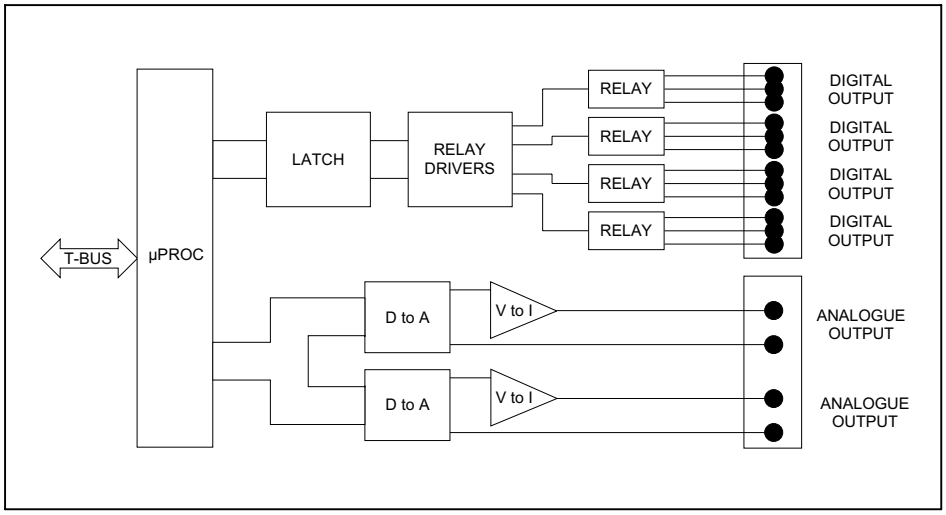


Figure 30 Combination Output Module Block Diagram

This module provides four digital outputs through changeover relays and two channels of DC analogue data. The analogues are 0-20mA DC current outputs and may be converted to DC voltage using external precision resistors.
Due to addressing restrictions, only one such module may be used in a Node.
Note: Analogue outputs do not require an external loop power supply.

Technical Specifications

Module Name	Combination Output
Part Number	IRDN210
No. of modules in a Node	1 maximum
Processor	80C31
Internal Interface	T2-BUS Slave Peripheral
Relay outputs	4 changeover
Loading	min 1mA@ 1V DC max 1A @ 240V AC 3A @ 120V AC 3A @ 30V DC
Output settling time	500mS maximum
Analogue Outputs	2 x 0-20mA DC
Precision	12 bit
Load resistance	250 Ω
Power Supply	11-14 V DC through T-Bus
Current Consumption	50 mA min. 120mA max.
Operating Temperature	-20°C to +70°C
User Connection	2 part screw terminals
Dimensions	152 x 167 x 32mm
Weight	0.6kg

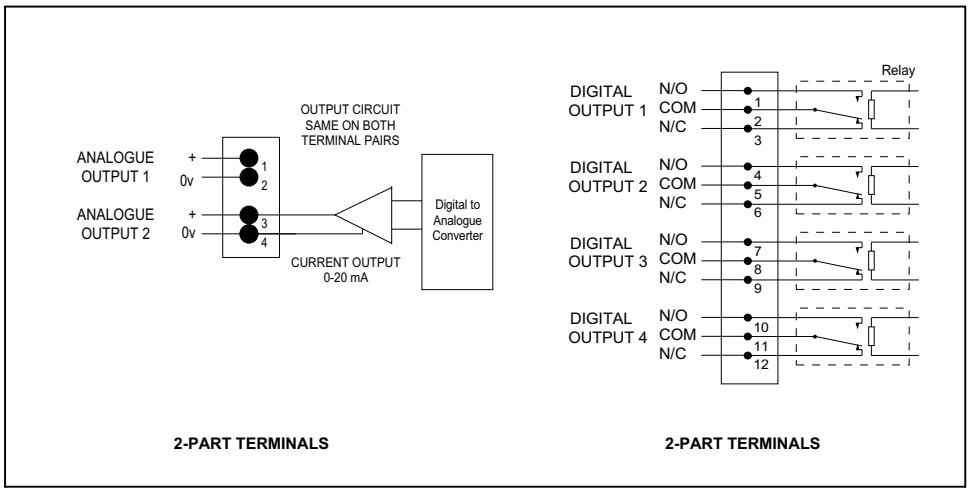


Figure 31 Combination Output Module Connection Chart

7.11 Low Power Input Module – IRDN211

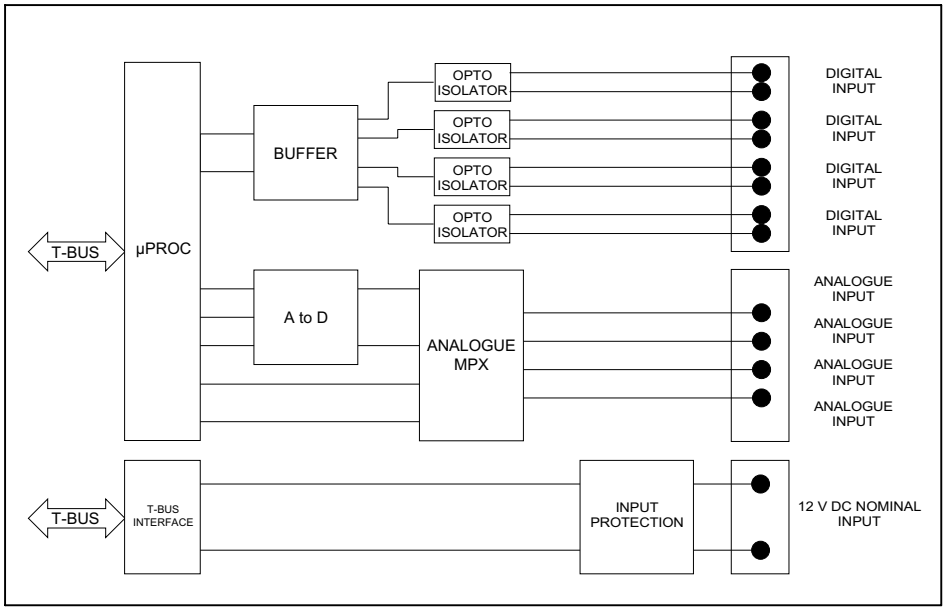


Figure 32 Low Power Input Module Block Diagram

This module is used to collect up to four digital steady-state inputs and four DC analogue values. The analogues may be either 1-5V DC or 4-20mA, switchable for each channel individually. The module may be connected directly to a nominal 12v DC power source. This module is used with a Communications Controller and optionally a DC Adaptor, to form a Low Power Node for locations without mains power supplies. It can also be used in conjunction with an IRDN212 Low Power Pulse Input Module.
Due to addressing restrictions, only one such module may be used in a Node.

Technical Specifications

Module Name	Low Power Input
Part Number	IRDN211
No. of modules in a Node	1 maximum
Processor	80C32
Internal Interface	T2-BUS Slave Peripheral
Digital Inputs	4 volt free
Analogue Inputs	4 channels 1-5 V DC 4-20 mA DC switchable
Precision	10 bit
Scan rate	1 second for all channels
Power supply	11-14v DC direct or 11-14v DC from DC Adaptor via T2-BUS
Current Consumption	100 mA typ. 300 uA in low power mode
Operating Temperature	-20°C to +70°C
User Connection	2 part screw terminals
Dimensions	152 x 167 x 32
Weight	0.3kg

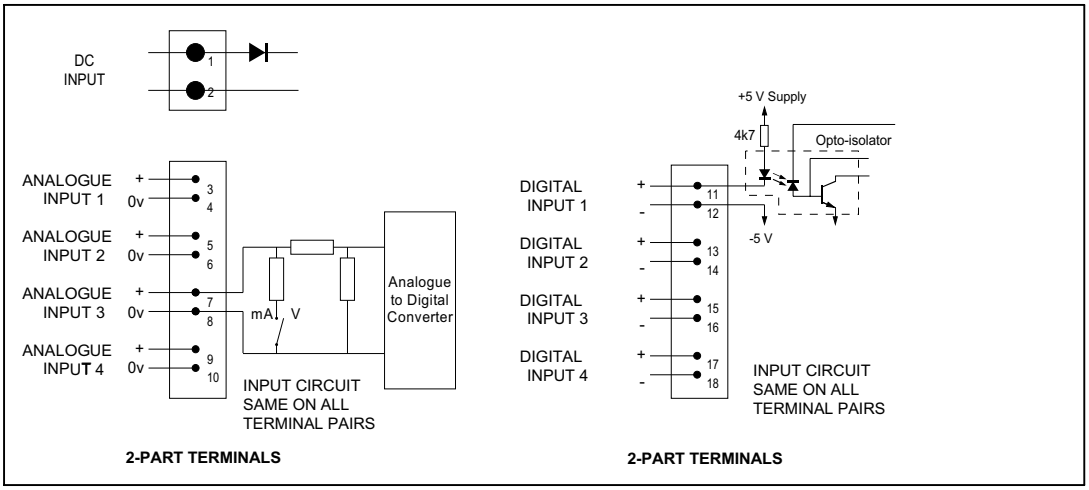


Figure 33 Low Power Input Module Connection Chart

7.12 Low Power Pulse Input Module – IRDN212

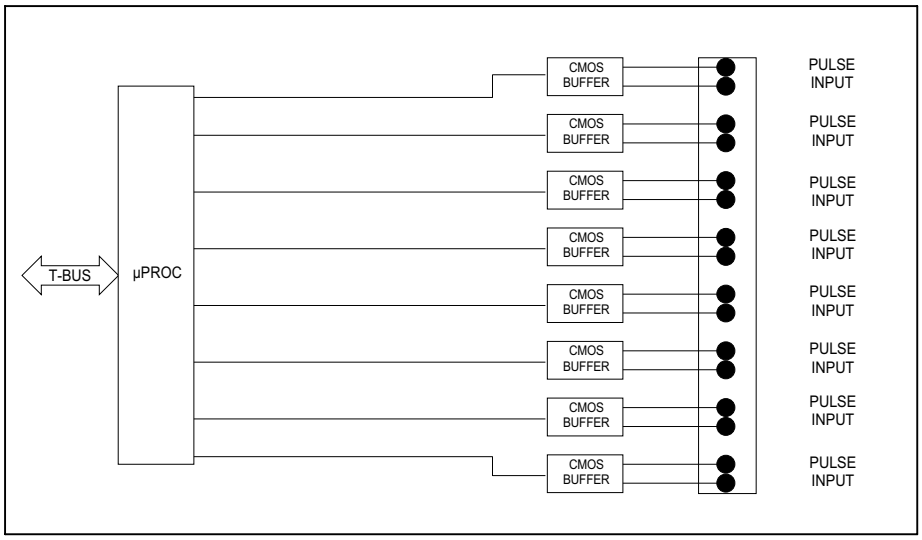


Figure 34 Low Power Pulse Input Module Block Diagram

This module is used to collect up to eight pulse counting inputs and has the added benefit of being able to be connected directly to a DC power source. This module is used with a Communications Controller and optionally a DC Adaptor, to form a Low Power Node for locations without mains power supplies. It can also be used in conjunction with an IRDN 211, Low Power Input Module.

Only pulses wider than 5mS will be detected with each input channel having a counter capable of storing a maximum count of 65535. The user must ensure that an appropriate transmission interval is selected to avoid counter overflows between transmissions. Eight LED's are provided to provide indication of pulse activity on each channel. The LED's can be switched 'OFF' via the on-board DIL switch. It should be noted that each illuminated LED will add approx. 2mA to the current consumption of the module.

Technical Specifications

Module Name	Low Power Pulse Input
Part Number	IRDN212
No. of modules in a Node	16 max.
Processor	PIC16C74
Internal Interface	T2-BUS Slave Peripheral
Pulse Inputs	8
Input Pulse Width	5 mS min.
Input Pulse Frequency	100 Hz max.
Power supply	11-14v DC direct or 11-14v DC via T2-BUS
Current Consumption	70 mA Typ. 5mA Low Power Mode (LED's switched OFF)
Operating Temperature	-20°C to +70°C
User Connection	2 part screw terminals
Dimensions	152 x 167 x 32
Weight	0.3kg

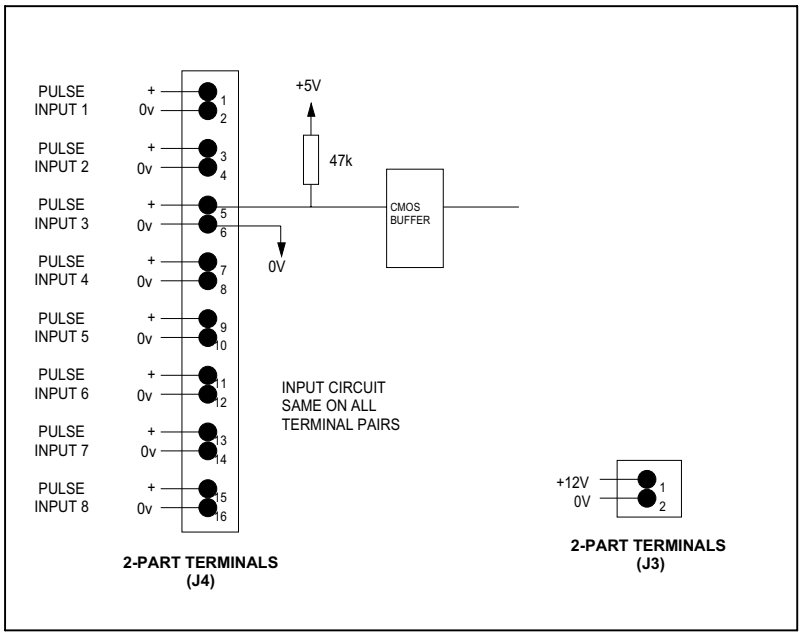


Figure 35 Low Power Pulse Input Module Connection Chart

7.13 Alarm Output Module – IRDN214

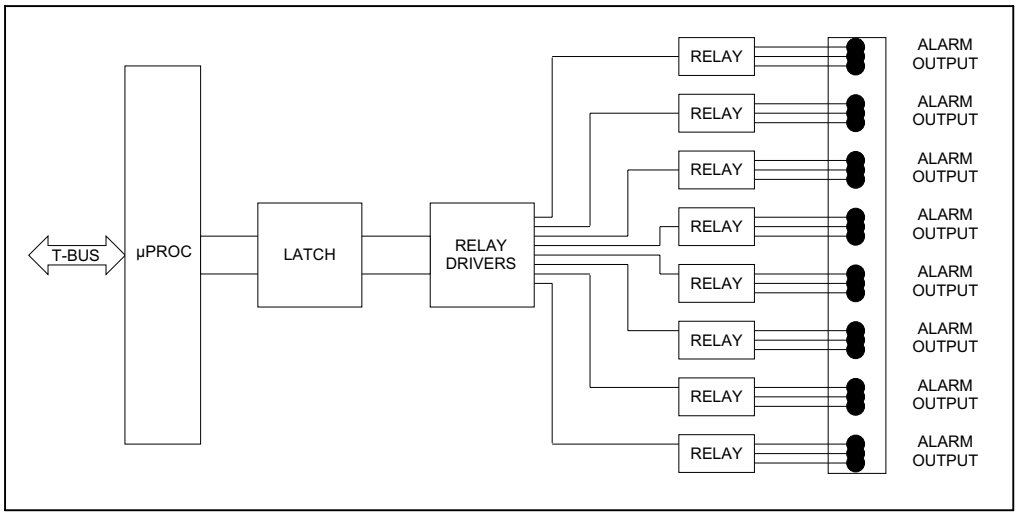


Figure 36 Alarm Output Module Block Diagram

The alarm output module allows an individual alarm output per Node, within the VersaNet2 network. The alarm occurs at the receiving end of the link being monitored. It is particularly useful in systems where the 'transmitter' is battery or solar powered.

The alarm output module has identical hardware to a digital output module IRDN201, but the software is different. In the non-alarm state the relays are energized.

OPERATION.

On 'power up', all alarm output relays will be energized and a software timer will be started. If no message is received within 30* minutes the relay will de-energize giving an alarm output. If a message is received at any time before the 30 minute period has elapsed the timer is re-started holding the relay in the energized 'no' alarm state.

* The 30 minute time is factory programmed within the EPROM. Other times can be supplied up to a maximum of 18 hours.

CONFIGURATION.

The alarm output board is installed in the receiving node in the same way as any other Input/Output module*. The module is set to a unique address for that node using SW1*. Having used an address for alarm outputs that address will no longer be available for digital outputs.

At the transmitting end of the link being monitored, a digital input must be configured to be sent to the specific relay selected for that purpose at the output end of the link.

For example in a system where: Network Name = ABC
The 'Transmitter' is Node 1
The 'Receiver' is Node 2
The alarm output card is given address 2

At 'Connection Screen'	Select 'IRDN200 (on board) from available list
	Select D0.1 from sub-tree
	Enter '2D2.3' in Destination Output box
	Select 'Connect' button

The above will cause relay 3 on alarm output module 2 to monitor transmissions from Node 1 and to de-energize if no message is received from Node 1 in 30 minutes.

Technical Specification

Module Name	Alarm Output
Part Number	IRDN201
No. of modules per Node	16 max
Processor	80C31
Internal Interface	T2-BUS Slave Peripheral
Relay Outputs	8 changeover
Loading	min 1mA @ 1V DC
	max 1A @ 240V AC
	3A @ 120V AC
	3A @ 30V DC
Output settling time	20 ms per channel from receipt of T-Bus command
Contact life expectancy (mechanical)	1 x 10^7 operations
Power Supply	11-14V DC through T2-BUS
Current Consumption	min 30 mA
	type 130 mA
	max 250 mA
Operating temperature	-20°C to +70°C
User connection	2 part screw terminals
Dimensions	152 x 167 x 32 mm
Weight	0.3kg

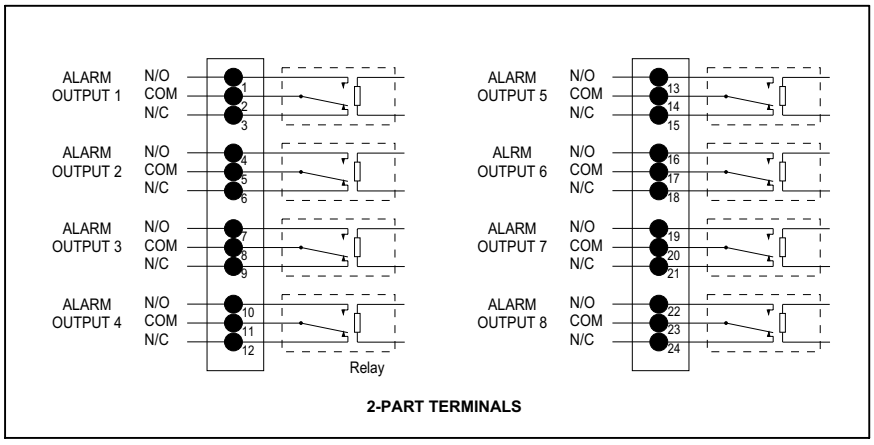


Figure 37 Alarm Output Module Connection Chart

Section 8 Accessories

8.1 Enclosures

Basic Enclosure

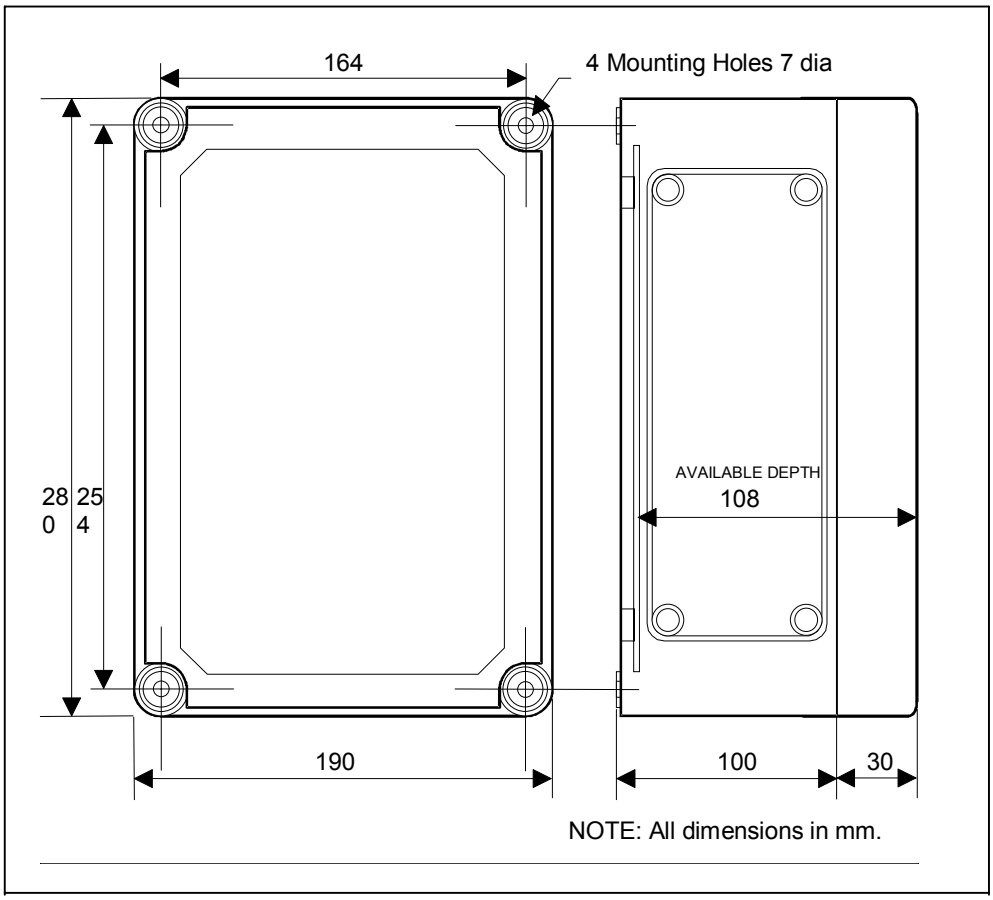


Figure 37 Mechanical Drawing of Basic Enclosure

The Basic Enclosure is an impact resistant, polycarbonate enclosure which offers protection from dust and moisture in accordance with IP67 (IEC529/DIN 40050/BS5490). It is moulded from homogeneous thermoplastic polycarbonate, is resistant to normal atmosphere corrosion and is resistant to most mineral and organic acids. Contact should be avoided, however, with organic solvents and strong alkalies. The material is self-extinguishing and does not release any toxic combustion products.

It is supplied complete with lid, gland plate, four cable glands and metal base plate, ready to take VersaNet modules. A depth of 108mm is available in an unexpanded enclosure. Enclosures may be bolted together or increased in depth using suitable accessories to accommodate larger numbers of modules.

The enclosure is supplied with a grey finish (RAL7035) and may be painted and machined with normal tools or ultrasonic welding apparatus. Cleaning should be performed with soap and water only.

Specifications

Part Name	Basic Enclosure
Part Number	ENC/001
Dimensions	190 x 280 x 130 (Available Depth 108mm)
Weight	1.5kg
No. in a node	No Limit
Cleaning	Soap & Water Only AVOID ORGANIC SOLVENTS or STRONG ALKALIES

8.1.1 Depth Extension Kit

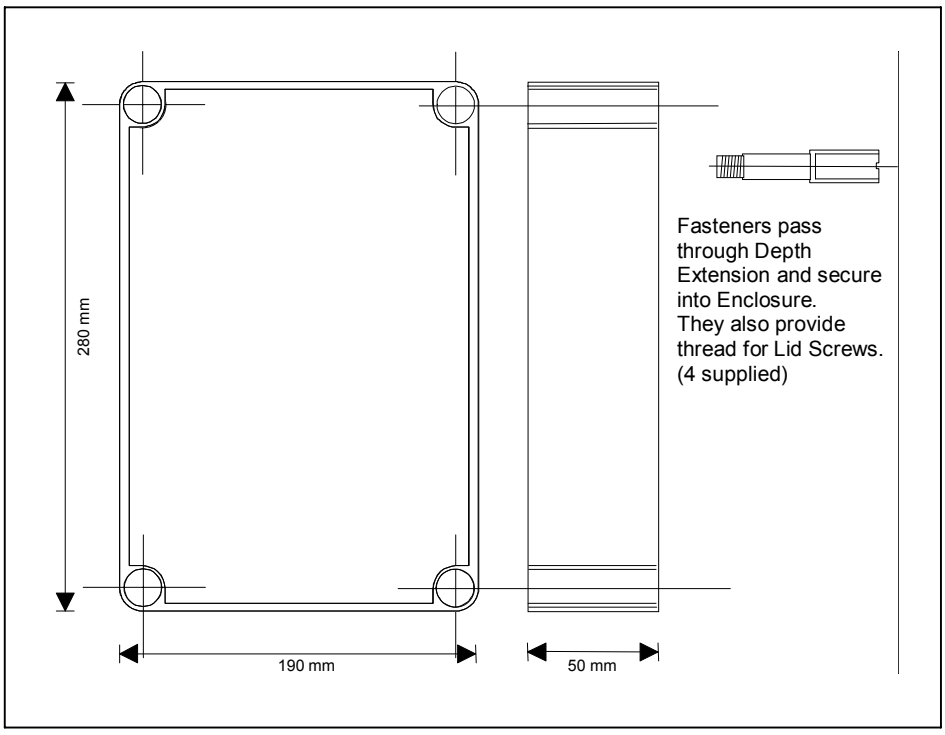

280 mm
190 mm
50 mm
Fasteners pass through Depth Extension and secure into Enclosure. They also provide thread for Lid Screws. (4 supplied)

Figure 38 Mechanical Drawing of Depth Extension Kit

The Depth Extension Kit is used to increase the available depth of the Basic Enclosure. Each extension provides an additional 50mm, therefore when the suggested maximum of 2 extensions are fitted, a total depth of 208mm is available. When fitted in accordance with the instructions in Section C of this manual, the IP67 protection is maintained.

Specifications

Part Name	Depth Extension Kit
Part Number	ENC/004
No. in a node	No Limit (maximum 2 per Basic Enclosure)
Weight	0.4 kg

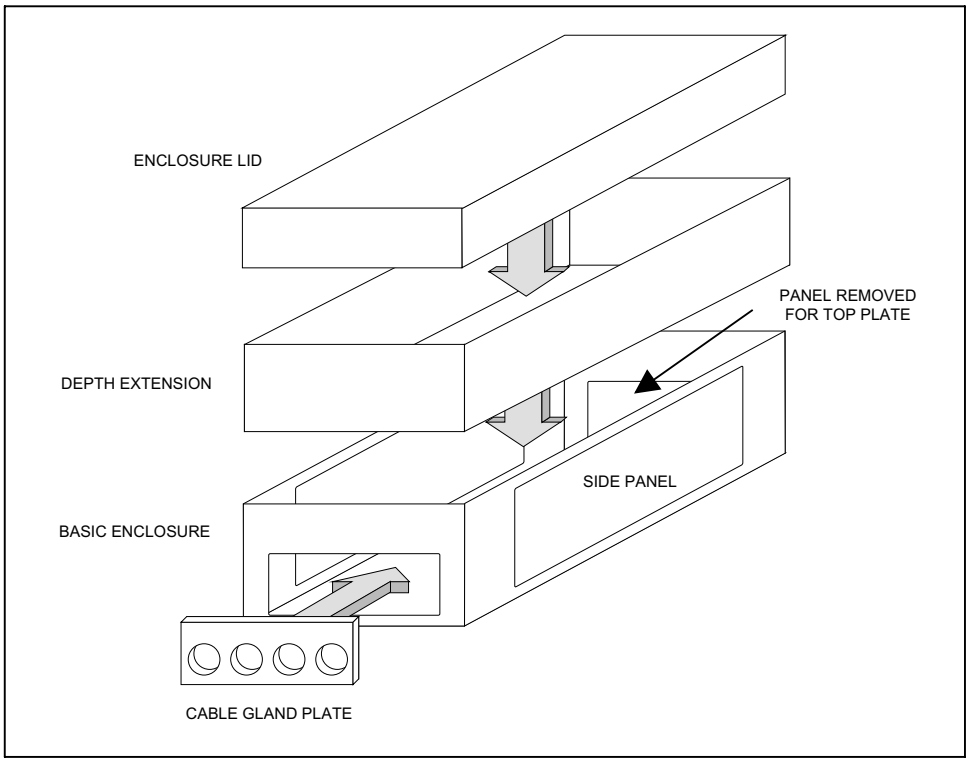


Figure 39 Example Enclosure Construction

8.1.2 Side Extension Kit

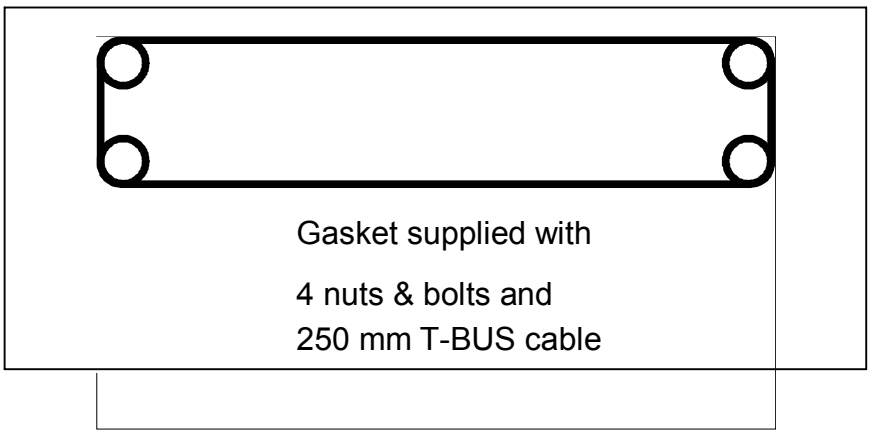


Figure 40 Side Extension Kit

The Side Extension Kit is used to connect two Basic Enclosures together to accommodate large numbers of modules.

It consists of a sealing gasket, four nuts and bolts and an extended T-BUS cable. When fitted in accordance with instructions in Section C of this manual, the IP67 protection is maintained.

Specifications

Part Name	Side Extension Kit
Part Number	ENC/002
No. in a node	No Limit

Dimensions - gasket	215 x 80mm
T2-BUS cable	250mm
Weight	0.05kg

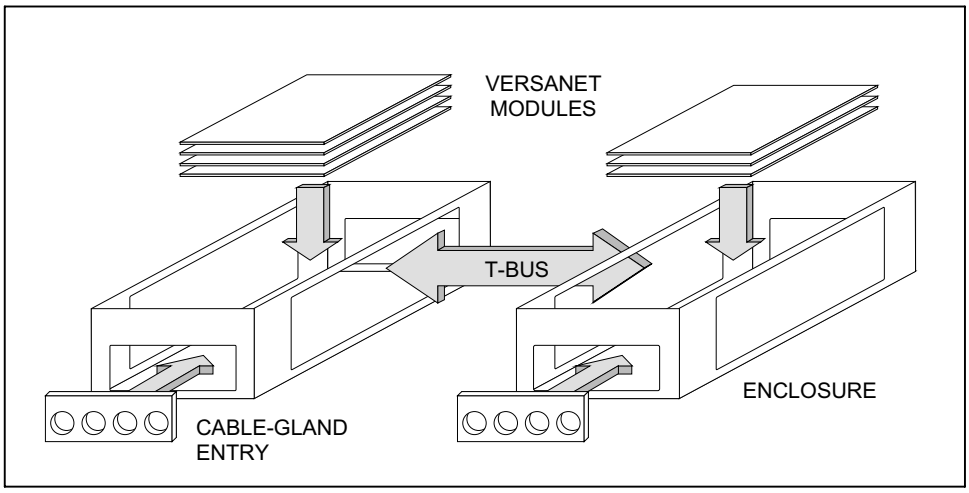


Figure 41 Example Enclosure Construction

8.1.3 Battery Mounting Kit

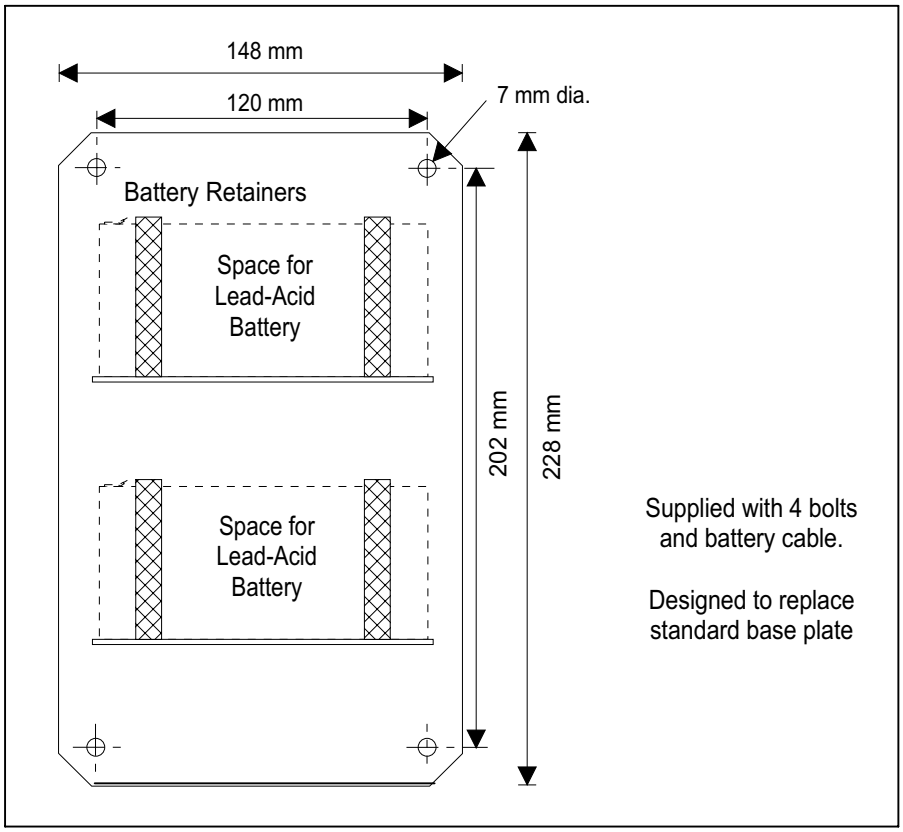


Figure 42 Mechanical Drawing of Battery Mounting Kit

The Battery Mounting Kit is used in place of the standard metal base plate to provide means of retaining two 12V batteries in a Basic Enclosure. It consists of a

formed metal base plate, battery retention straps, fasteners and a battery cable to connect to the relevant VersaNet Module (Low Power Input or DC Adaptor)

Specifications

Part Name	Battery Mounting Kit
Part Number	ENC/005
No. in a node	1 maximum
Dimensions - base plate	148 x 228 mm
- battery cable	250mm
Weight	0.5kg
Battery space	2 off 150 x 100 mm

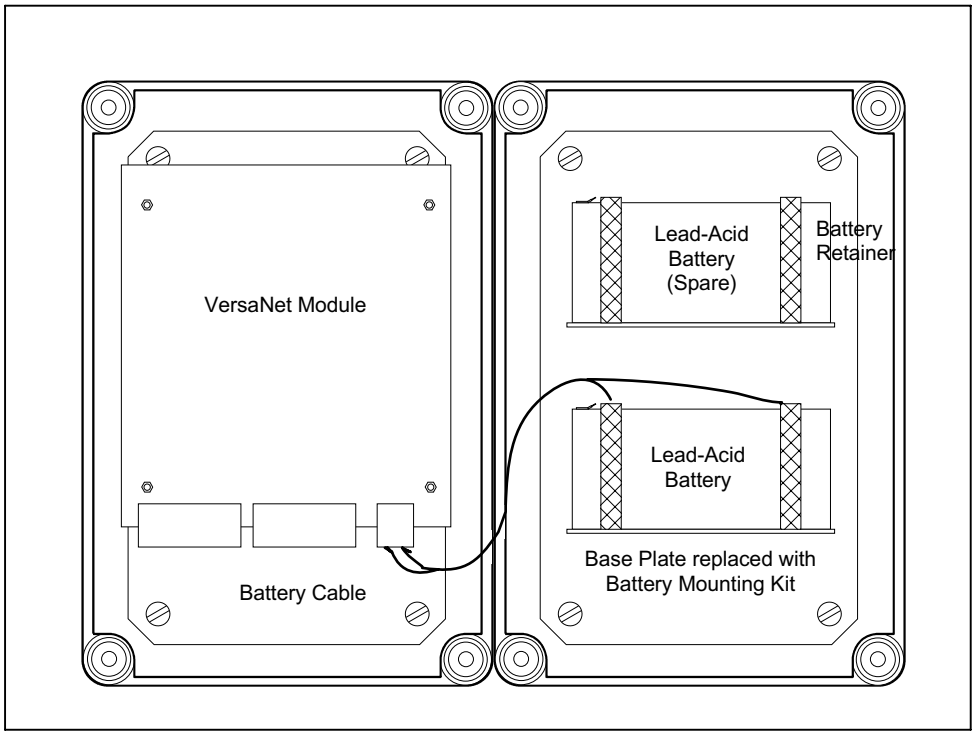


Figure 43 Battery Kit Construction

8.1.3 Antenna Top Plate Mounting Kit

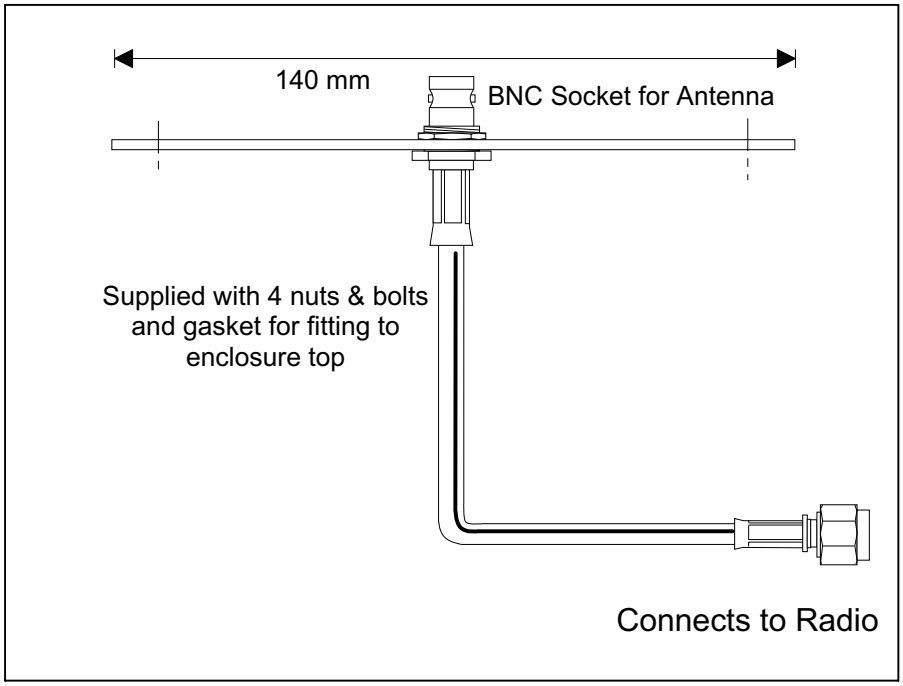


Figure 44 Mechanical Drawing of Antenna Top Plate Mounting Kit

The Antenna Mounting Kit is used to provide a means of connecting an enclosure-top antenna directly to a VersaNet enclosure. It consists of a metal plate fitted with a short RF cable, sealing gasket and four nuts and bolts. When fitted in accordance with the instructions in Section C of this manual, the IP67 protection is maintained.

Specifications

Part Name	Antenna Top Plate Mounting Kit
Part Number	ENC/003
External RF Connection	BNC female, bulkhead mounted
No. in Node	1 maximum
Dimensions - plate	140mm x 50mm x 2mm
- cable	300mm

8.1.5 Antenna Bulkhead Cable Kit

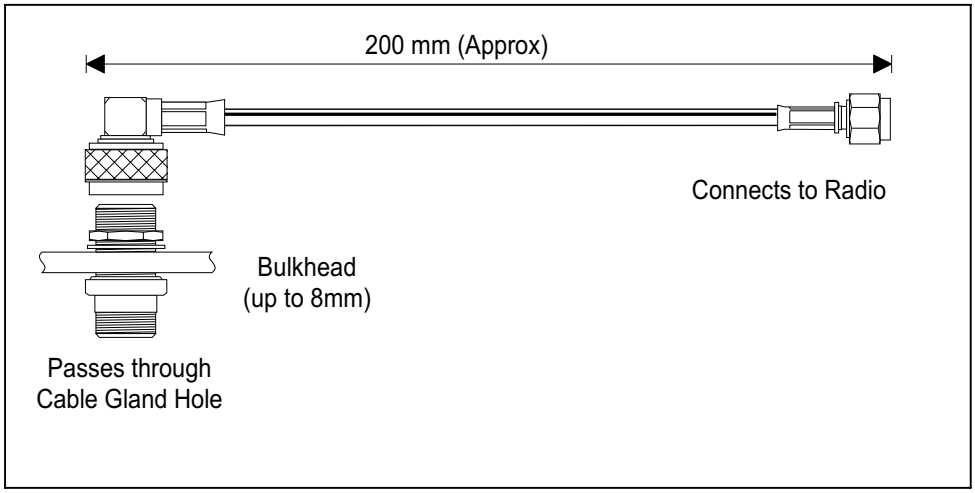


Figure 45 Antenna Bulkhead Cable Kit

The Antenna Bulkhead Cable Kit is used to provide an N-type female bulkhead socket in the gland plate of the Basic Enclosure. It is fitted in place of a standard cable gland and allows direct connection of external antennas or feeders.

Specifications

Part Name	Antenna Bulkhead Cable Kit
Part Number	ENC/007
No. in a node	1 maximum
Dimensions	300 mm x 10 mm dia. (approx)
Weight	0.1kg

8.2 Antennas

8.2.1 ½ Wave Whip Antenna

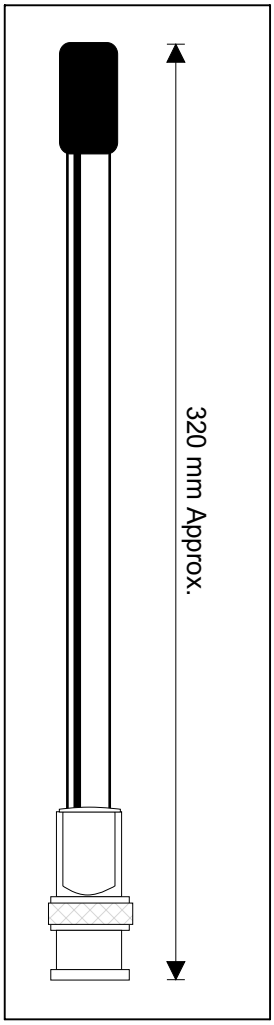


Figure 46

The ½-Wave Whip Antenna is used in conjunction with the Antenna Mounting Kit for those applications requiring a relatively short transmission range. The antenna is nominally rated at a loss of 3 dB and is suitable for ranges up to about 1km, dependent upon topography.

The construction is a corrosion-proof metal shaft with a resistive black plastic cover. The connector is black chromium plated brass.

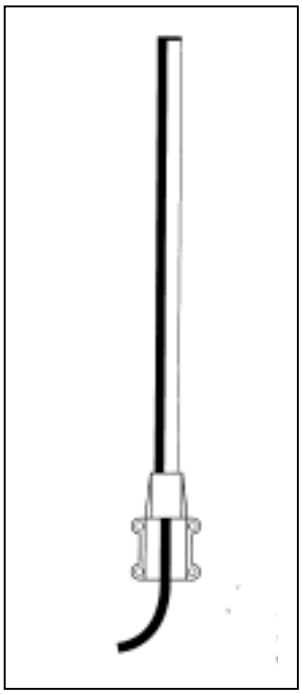
Note: The BNC connection should be sealed with self amalgamating tape after installation.

Specifications

Part Name	½-Wave Whip Antenna
Part Number	AT006
No. in a node	1 maximum
Frequency Range	406-470 MHz
VSWR	<2 when mounted on top plat
Impedance	50 Ohms
Connector	BNC

ANT006A	440 – 470 MHz	300mm Long
ANT006C	406 – 440 MHz	330mm Long

8.2.2 End Fed Dipole / Colinear



The end fed dipole and collinear antennas are a professional range of products designed for outside installations requiring mid to long range transmissions.

The construction is a parallel glass fibre tube with an integral die cast aluminium alloy mounting bracket.

The Colinear antennas offer 3 or 6 dB gain, which can be useful to recover losses in feeder cable.
Note: Check with local regulations to ensure the allowed ERP is not exceeded.

The antenna is supplied with 2 x 'U' bolts for mounting to a standard 50mm diameter pole and is complete with a 3 metre tail of RG213 cable terminated with an 'N' type male connector.

Specification

Part number	ANT008
Frequency range	400 – 470MHz
Impedance	50 Ω
VSWR	<1.5 : 1
Polarization	Vertical

Figure 47

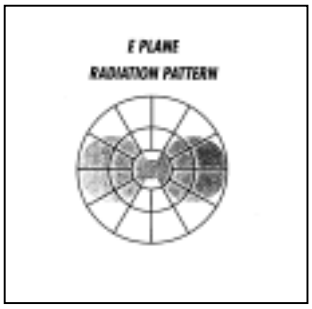


Figure 48

Endfed Dipole

Part no	ANT008
Gain	0 dBd
Length	0.6mtrs
Weight	0.6Kg
Wind loading	37 N

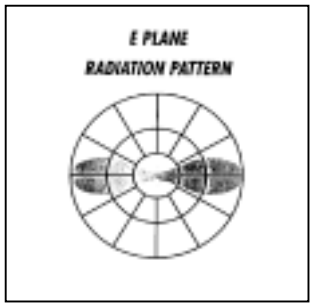


Figure 49

3dB Colinear

Part no	ANT008-3
Gain	3dBd
Length	1.6mtrs
Weight	1.0 Kg
Wind loading	70 N

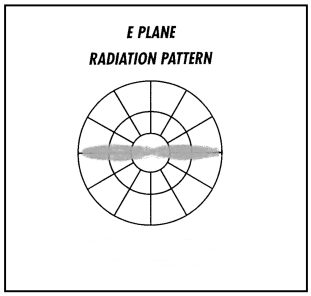


Figure 50

6 dB Colinear

Part no	ANT008-6
Gain	6dBd
Length	3.1mtrs
Weight	2.0 Kg
Wind loading	156 N

8.2.3 Yagi Antenna

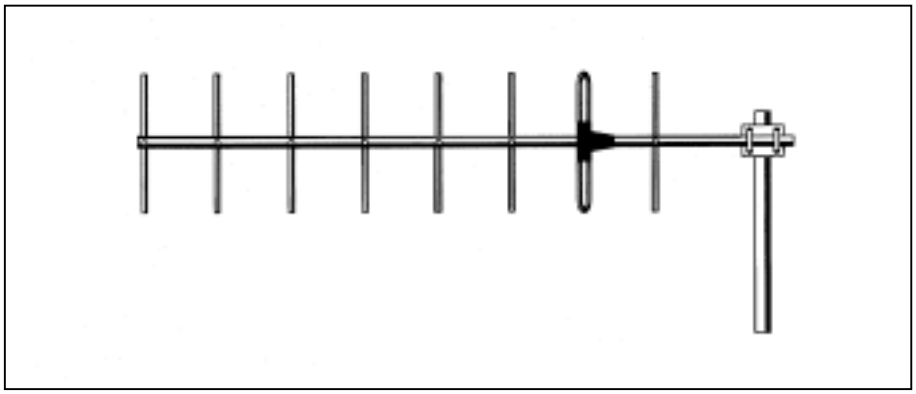


Figure 51

The 2 element and 8 element Yagi antennas are a professional range of products designed for long distance applications or where a directional signal is required i.e. to avoid receiving other nearby transmissions.

The 2 element Yagi offers a gain of 3 dBd and the 8 element, 10dBd.
Note: Check with local regulations to ensure the allowed ERP is not exceeded.

The construction is from aluminium alloy tubing with a zinc alloy diecast saddle clamp for mounting to a standard 50mm pole. The antenna is supplied complete with a 3 mtr tail of RG213 cable terminated with a 'N' type male connector.

Specification

Freq range	400 – 470MHz
Impedance	50 Ω
VSWR	<1.5 : 1
Polarisation	Horizontal or Vertical

	2 Element	8 Element
Part no	ANT009-2	ANT009-8
Gain	3 dBd	10 dBd
Length	0.6 mtrs	1.6 mtrs
Weight	1.8 Kg	3.5 Kg
Wind loading	54 N	128 N
Beamwidth (H)	84^0	50^0
Beamwidth (E)	62^0	43^0

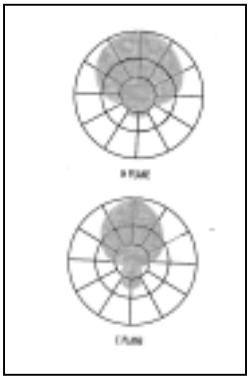


Figure 52 – 2 Element

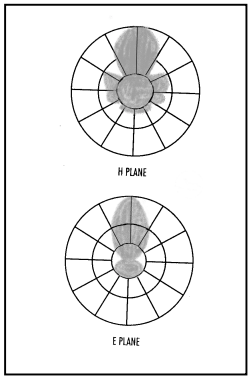


Figure 53 – 8 Element

8.2.4 Low Profile Vandal Resistant

This antenna is a small, lightweight, low profile unit suitable for any application where there is a height restriction. Because of its shape and mounting position, it also offers a degree of protection against vandalism. It is mountable on most surfaces as the ground plane is integral.

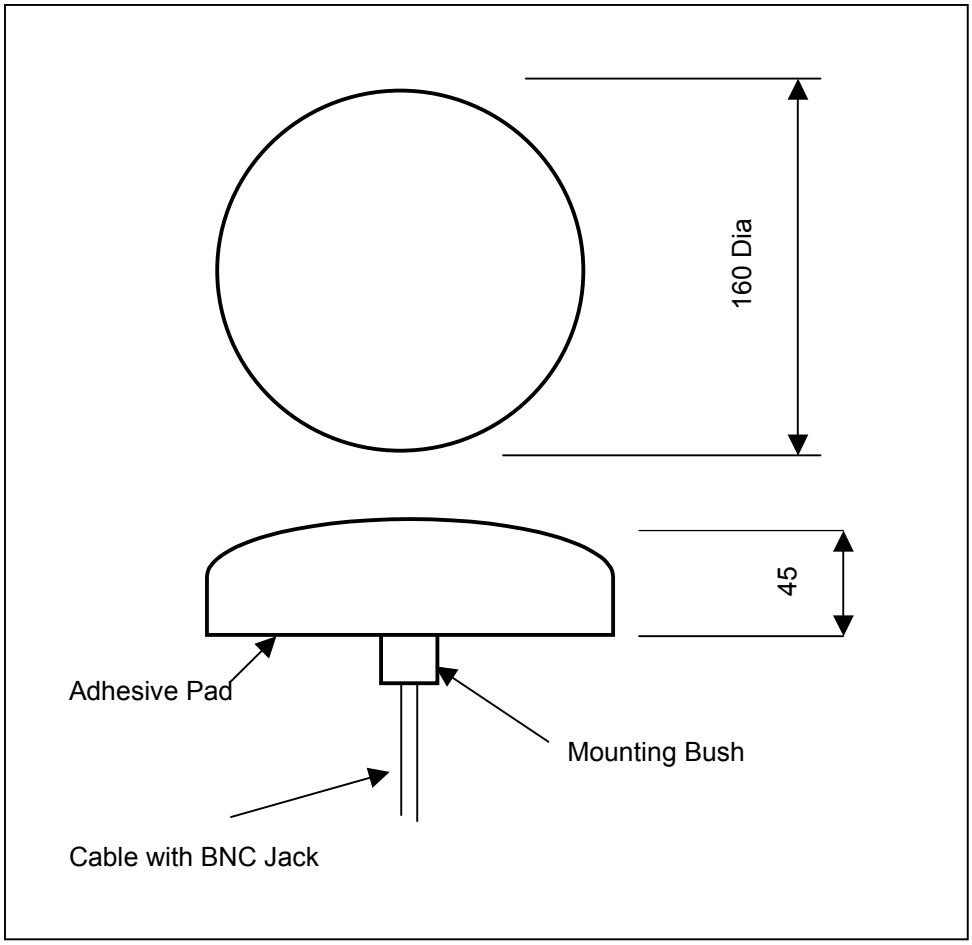


Figure 54 Low Profile Antenna

Specification

Part no	ANT014
Frequency range	400-470 MHz
VSWR	<1.5 :1
Impedance	50 Ohm
Polarisation	Vertical
Connector	BNC + 0.5 mtr of cable

8.3.5 Antenna Mounting Hardware

RDT can supply the following mounting hardware to assist with the installation of antennas.

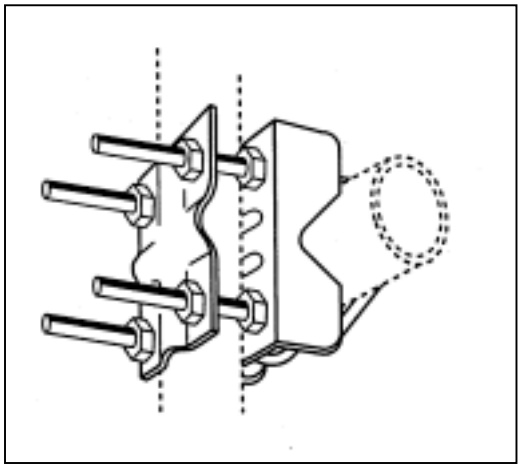


Figure 55
Standard Yagi Clamp

Designed to fit standard 50mm Poles and supplied with 2 x U bolts and nuts.

Part Number 1329

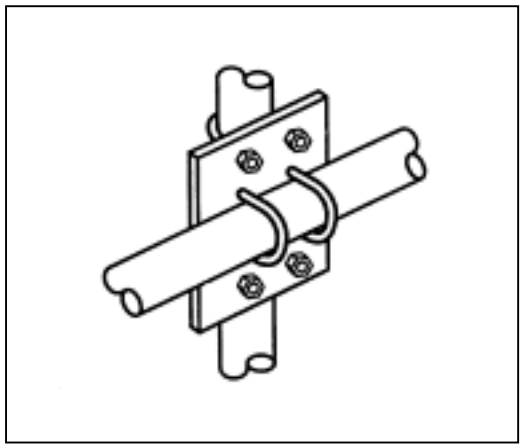


Figure 56
Crossover Clamp 50mm x 32mm (2” x 1¼”)

Supplied with 4 x U bolts and nuts

Part number 1330

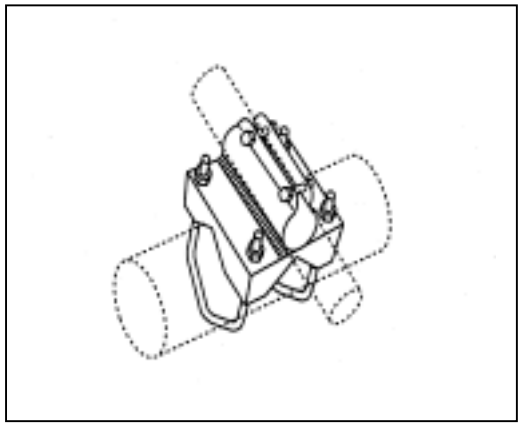


Figure 57
Standard Colinear Clamp

Designed to fit standard 50mm poles and supplied with 2 x U bolts and nuts.

Part number 1331

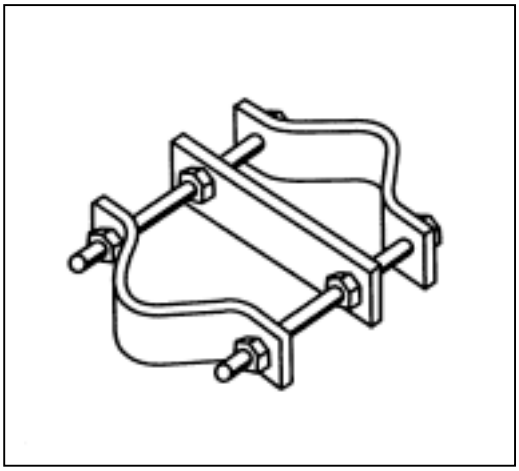


Figure 58
Colinear Parallel Clamp

Designed to fit standard 50mm poles and supplied with 2 x fixing bolts and nuts.

Part number 1332

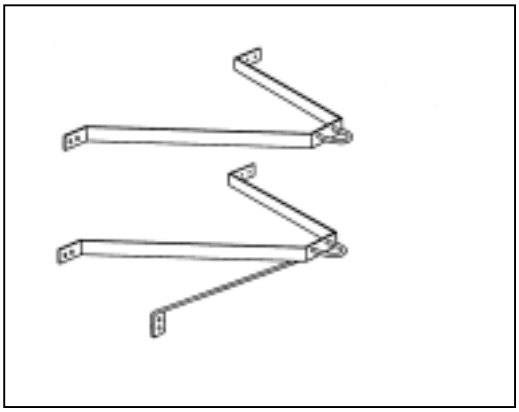


Figure 59
Wall Mounting ‘A’ Brackets

Supplied as a pair with 2 x U bolts and nuts

Part number 300mm stand-off 1333
450mm stand-off 1334
600mm stand-off 1335

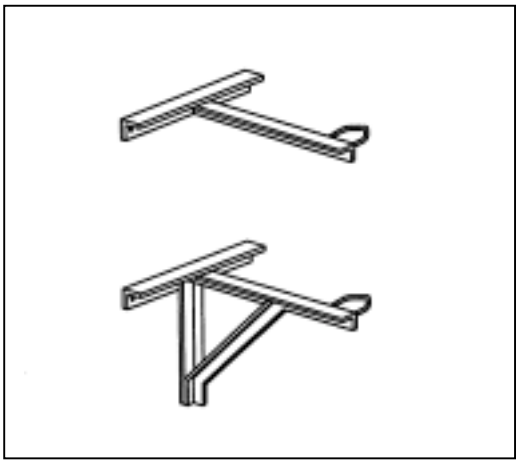


Figure 60
Wall Mounting ‘T’ and 'K’ Brackets

Supplied as a pair with 2 x U bolts and nuts

Part number 300mm stand-off 0074
450mm stand-off 0076
600mm stand-off 1336

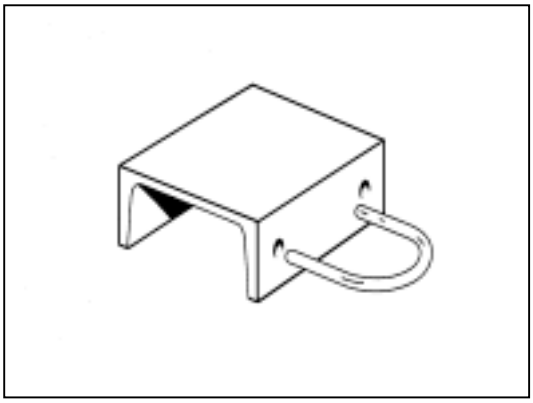


Figure 61
Channel Bracket

Supplied with 2 x U bolts and nuts.

Part number 1337

8.3 Cables

The following cables are available from RDT stock:

RDT Part No	Length	Description	Application
CAB0019	1.5mtrs	9 Way ‘D’ Skt to 9 Way ‘D’ Skt	RS232 Data Highway Port
CAB0019	1.5mtrs	9 Way ‘D’ Skt to 9 Way ‘D’ Skt	RS232 Configuration Port
CAB1338	450mm	9 Way ‘D’ Skt to 15 Way ‘min D’ Plg	VN2 to GSM Modem
CAB1339	1.5mtrs	9 Way ‘D’ Skt to 25 Way ‘D’ Plg	VN2 to Wire Line Modem
CAB1622	110mm	10 Way IDC Skt to 10 Way IDC Skt	T2-BUS
CAB1623	400mm	10 Way IDC Skt to 10 Way IDC Skt	T2-BUS
CAB1610	400mm	URM43 BNC bulkhead to SMA male	Radio to Top Plate
CAB1611	400mm	URM43 ‘N’ type male to SMA male	Radio to Bulkhead
CAB001-1	1mtr	RG213 ‘N’ type male to ‘N’ type male	VN2 to Antenna
CAB001-3	3mtr	RG213 ‘N’ type male to ‘N’ type male	VN2 to Antenna
CAB-001-5	5mtr	RG213 ‘N’ type male to ‘N’ type male	VN2 to Antenna
CAB001-10	10mtr	RG213 ‘N’ type male to ‘N’ type male	VN2 to Antenna
CAB001-15	15mtr	RG213 ‘N’ type male to ‘N’ type male	VN2 to Antenna
CAB001-20	20mtr	RG213 ‘N’ type male to ‘N’ type male	VN2 to Antenna
CAB001-25	25mtr	RG213 ‘N’ type male to ‘N’ type male	VN2 to Antenna
CAB001-30	30mtr	RG213 ‘N’ type male to ‘N’ type male	VN2 to Antenna

8.3.1 Connectors

RDT Part No	Description	Application
0022	2 Way free socket	DC input
0029	3 Way free socket	Data I/O
0013	4 Way free socket	Data I/O
1063	5 Way free socket	Data I/O
0042	8 Way free socket	Data I/O
0048	12 Way free socket	Data I/O
0049	16 Way free socket	Data I/O
0879	9 Way ‘D’ socket	RS232
0880	9 Way ‘D’ cover and retaining screws	RS232
0511	SMA male for URM43	Connection to Radio
0510	R/A ‘N’ type male for URM43	Connection to Antenna
0525	‘N’ type male straight, for RG213	Antenna cable

8.4 Power Supplies

There is a range of 4 power supplies, 3 switch mode and 1 linear for use when battery back-up is required.

8.4.1 1 Amp Switch Mode (Part number PSU1291)

Specification

Input Voltage Range	85-264 VAC
Inrush Current	20A /115 VAC
	40A / 230 VAC
Output Power	1A Continuous
Output Voltage	12VDC Nominal
Size	90L x 51W x 22H
Input Connector	Mates with Molex 09-50-3031
Output Connector	Mates with Molex 09-50-3041

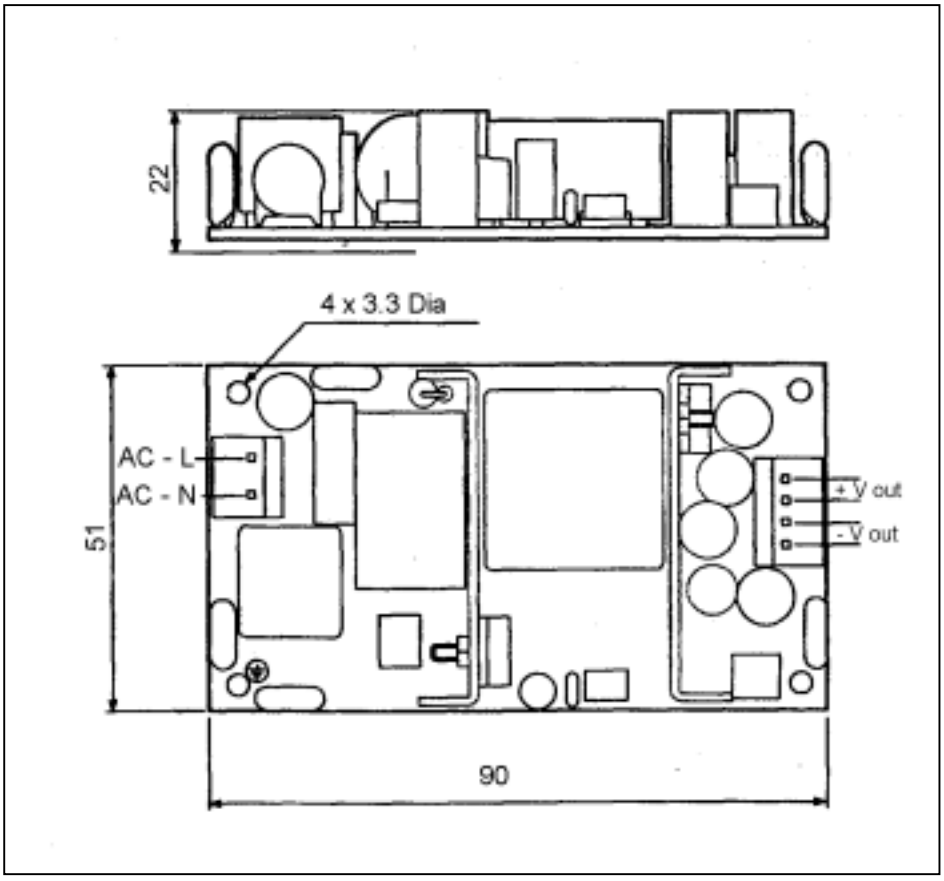


Figure 62 1Amp power supply

8.4.2 2 Amp Switch Mode (Part number PSU1292)

Specification

Input Voltage Range	90-264 VAC
Inrush Current	50A / 264 VAC
Output Power	2A Continuous
Output Voltage	12VDC Nominal
Size	102L x 51W x 32H
Input Connector	Mates with Molex 09-50-3031
Output Connector	Mates with Molex 09-50-3041

8.4.3 3 Amp Switch Mode (Part number PSU1293)

Specification

Input Voltage Range	90-264 VAC
Inrush Current	50A / 264 VAC
Output Power	3A Continuous
Output Voltage	12VDC Nominal
Size	102L x 51W x 32H
Input Connector	Mates with Molex 09-50-3031
Output Connector	Mates with Molex 09-50-3041

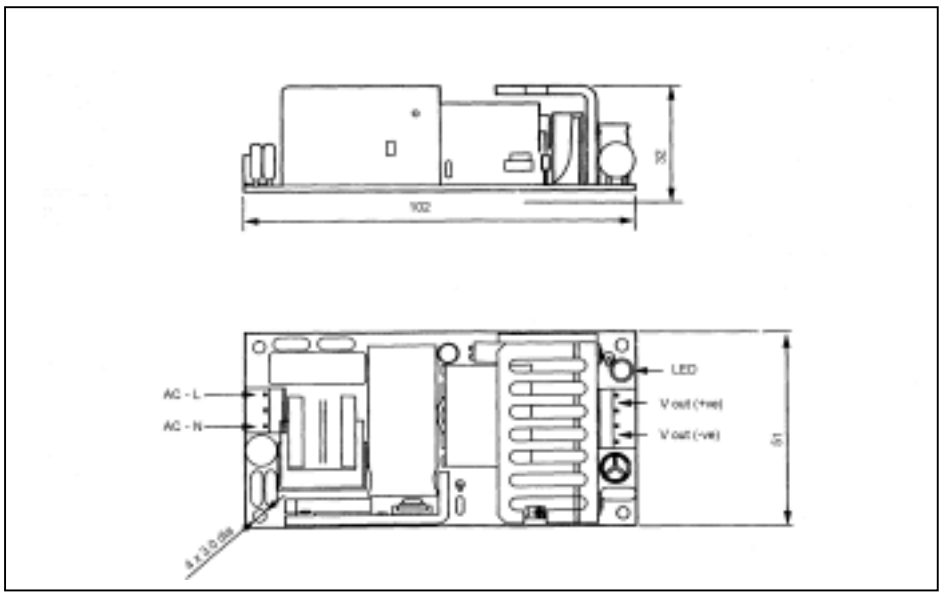


Figure 63 2 Amp and 3 Amp Power Supplies

8.4.4 3 Amp Linear Power Supply / Battery Charger (Part number PSU1289)

This model is a high power linear power supply / battery charger , with automatic change over on mains fail. See Section 3.4.4 of this manual for connection and operational details. The unit will also switch an output to provide a mains fail alarm.

Specification

Input Voltage Range	*220 – 240 VAC
Output Power	3 Amp continuous
Output Voltage	12VDC Nominal
Size	172L x 90W x 70H
Weight	1.72 Kg

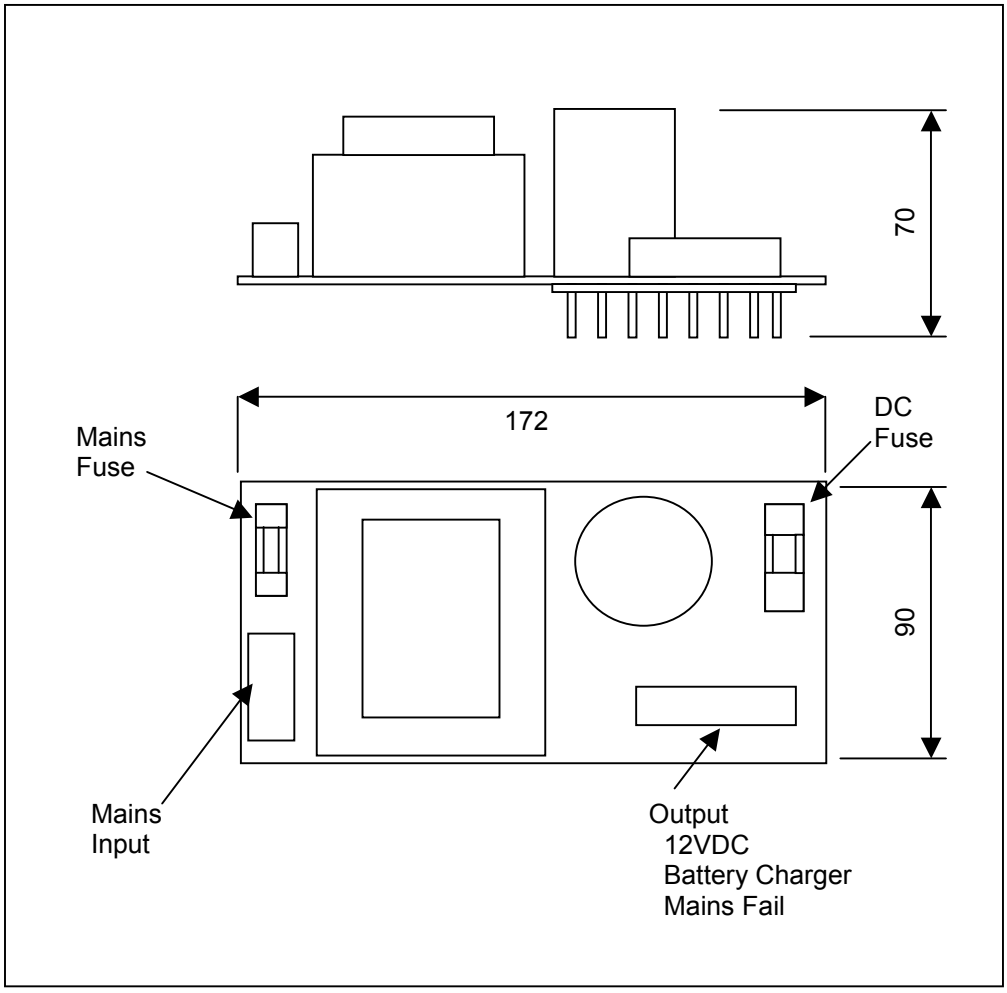


Figure 64 3 Amp Linear Power Supply / Charger

8.5 GSM Modem

The VersaNet2 software, has been specifically designed to interface with the Wavecom WMOD2B dual-band GSM Modem. Other GSM Modems may work perfectly well with VersaNet2, but their operation cannot be guaranteed. For example, most modems use a similar command set in normal point to point mode, but they seem to use different protocols for SMS messaging.

Before using the modem, it will be necessary to purchase a SIM Card and set up a service agreement with a network provider. Make sure that the network provider selected has good coverage in the proposed area. In general it is better to select a 900MHz system because the coverage is more widespread and the modem operates at a higher power level.

Specification

Part number	WMOD2B
Dual Band	900 / 1800 MHz
Size	98L x 54W x 25H
Supply	12VDC @ 130mA typ. (900) 12VDC @ 95mA typ (1800)
Current Idle Mode	4mA
Antenna connection	SMA
RS232 connection	15 pin sub 'D'
Power in	4 pin Micro-Fit

LED Indicator Functions

LED off	Modem switched off
LED on	Modem on, connecting to Network
LED on flashing slowly	Modem connected, Idle mode
LED on flashing rapidly	Modem communicating with Network

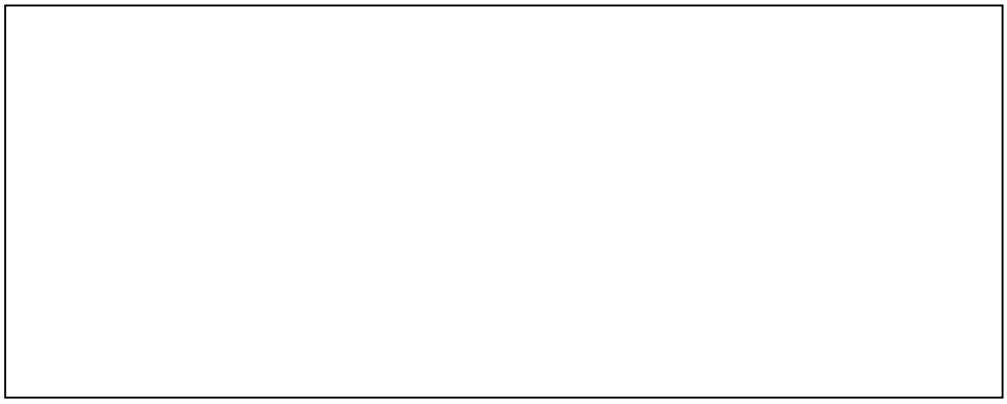


Figure 65 Mechanical details of WMOD2B GSM Modem

Section 9 Appendices

9.1 T2-BUS Interface

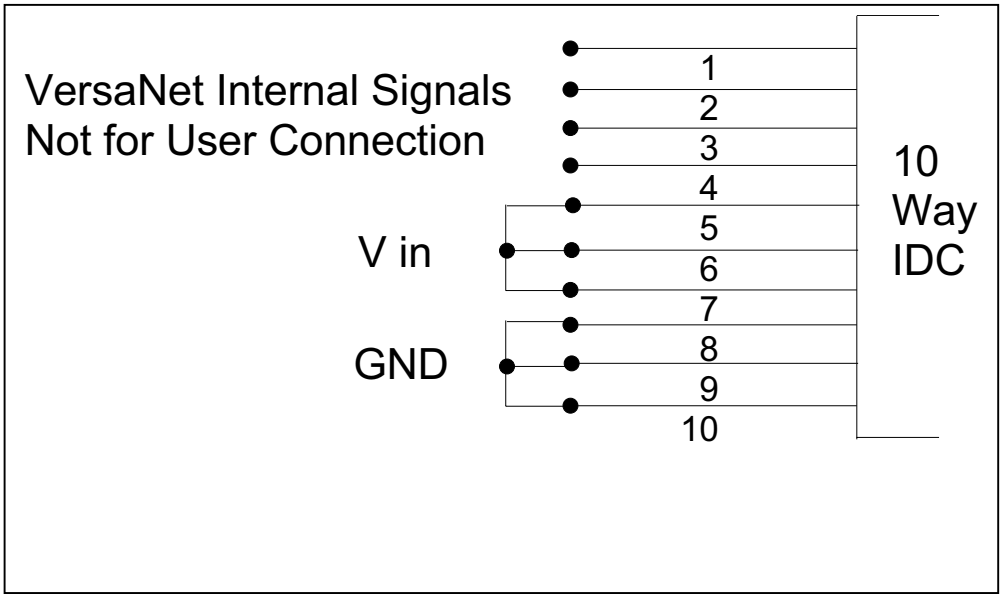


Figure 66 T2-BUS Interface Connections

T2-BUS is the proprietary communications protocol between all VersaNet2 modules in a node. It is a secure, robust bit-bus structure that permits all processors to communicate directly.

In some circumstances, it may be necessary for system builders or end users to construct spare T2-BUS cables. This may be done easily using standard components. The cable is a 10 way keyed IDC parallel cable.

9.2 RS232 Data Highway Port

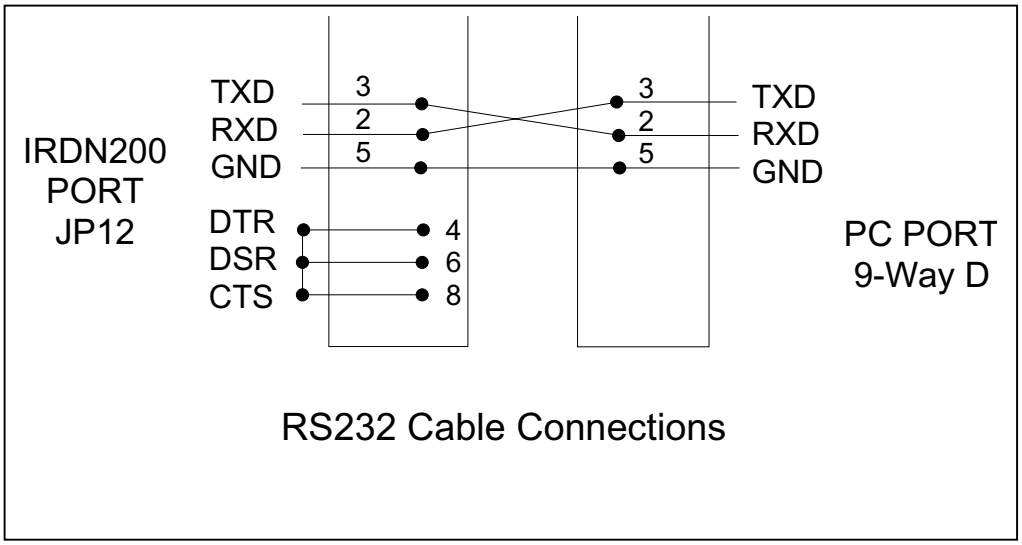


Figure 67 RS 232 Data Highway Port Connections

The RS232 Data Highway Port on the Communications Controller (JP12) is used to communicate with external process instruments and computers that utilize the MODBUS protocol.

9.3 RS232 Configuration Port

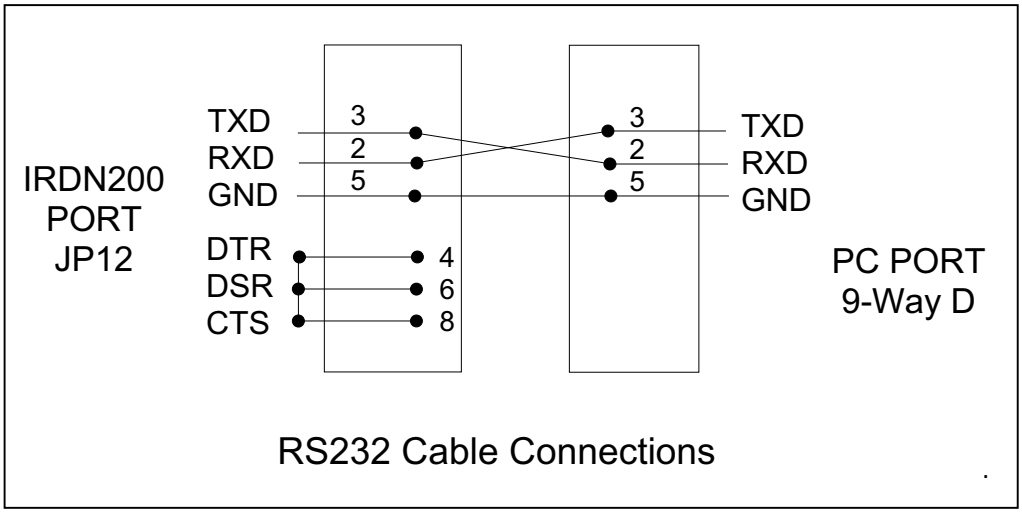


Figure 68 RS232 Configuration Port Connection

In order to configure a VersaNet 2 node or to monitor local I/O, a PC running Windows 95 (or later) is plugged into the Configuration port on the Communications Controller (JP7). The serial port on the PC must be configured as follows:-

PC Serial Port Configuration

Baud Rate	9600
Parity	None
No. of Data Bits	8
No. of Stop Bits	1

9.4 Modbus Protocol

Controllers can be setup to communicate on standard Modbus networks using either of two transmission modes: ASCII or RTU. Users select the desired mode, along with the serial port communication parameters (baud rate, parity mode, etc.), during configuration of each controller. The mode and serial parameters must be the same for all devices on a Modbus network.

The selection of ASCII or RTU mode pertains only to standard Modbus networks. It defines the bit contents of message fields transmitted serially on those networks. It determines how information will be packed into the message fields and decoded.

On other networks like MAP and Modbus Plus, Modbus messages are placed into frames that are not related to serial transmission. For example, a request to read holding registers can be handled between two controllers on Modbus Plus without regard to the current setup of either controller's serial Modbus port.

ASCII Modbus

When controllers are setup to communicate on a Modbus network using ASCII (American Standard Code for Information Interchange) mode, each 8-bit byte in a message is sent as two ASCII characters. The main advantage of this mode is that it allows time intervals of up to 1 second top occur between characters without causing an error.

The format of each byte in ASCII code is:-

Coding system: Hexadecimal, ASCII characters 0-9, A-F.
One hexadecimal character contained in each ASCII character of the message.

Bits per Byte: 1 start bit
7 data bits, least significant bit sent first
1 bit for even/odd parity; no bit for no parity
1 stop bit if parity is used; 2 stop bits for no parity

Error check field: Longitudinal Redundancy Check (LRC)

RTU Mode

When controllers are setup to communicate on a Modbus network using RTU (Remote Terminal Unit) mode, each 8-bit byte in a message contains two 4-bit hexadecimal characters. The main advantage of this mode is that its greater character density allows better data throughput than ASCII for the same baud rate. Each message must be transmitted in a single steam.

The format for each byte in RTU mode is:-

Coding system: 8-bit binary, hexadecimal 0-9, A-F
Two hexadecimal characters contained in each 8-bit field of the message.

Bits per byte: 1 start bit
8 data bits, least significant bit sent first
1 bit for even/odd parity; no bit for no parity
1 stop bit if parity is used; 2 stop bits for no parity

Error check field: Cyclical Redundancy Check (CRC)

Modbus Message Framing

In either of the two serial transmission modes (ASCII or RTU), a Modbus message is placed by the transmitting device into a frame that has a known beginning and ending point. This allows receiving devices to begin at the start of a message, read the address portion and determine which device is addressed (or all devices, if the message is broadcast), and to know when the message is completed. Partial messages can be detected and errors an be set as a result.

On networks like MAP or Modbus Plus, the network protocol handles the framing of messages with beginning and end delimiters that are specific to the network. Those protocols also handle delivery to the destination device, making the Modbus address field imbedded in the message unnecessary for the actual transmission. (The Modbus address is converted to a network node address and routing path by the originating controller or its network adapter).

ASCII Framing

In ASCII mode, messages start with a 'colon' (☺ character (ASCII 3A hex), and end with a 'carriage return-line feed' (CRLF) pair (ASCII 0D and 0A hex).

The allowable characters transmitted for all other fields are hexadecimal 0-9, A-F. Networked devices monitor the network bus continuously for the 'colon' character. When one is received, each device decodes the next field (the address field) to find out if it is the addressed device.

Intervals of up to one second can elapse between characters within the message. If a greater interval occurs, the receiving device assumes an error has occurred. A typical message frame is shown below.

START	ADDRESS	FUNCTION	DATA	LRC CHECK	END
1 CHAR	2CHARS	2 CHARS	N CHARS	2 CHARS	2 CHARS CRLF

Reading Pulses Using Modbus

There is no provision in the Modbus protocol to directly read pulse counts. This may be achieved however using the following procedure.
At the transmitting end, programme the node to send its pulse input to a virtual output at the receiving node.
e.g. P0.1 to 2P3.1 (address P3.1 at node 2 where no physical output card exists)

The pulse count will be sent to this virtual location at node 2 and can be read by Modbus.
To read the pulse count treat it as an analogue read (Function Code 3), but add 10,000 to the register value.

e.g. Register value for A3.1 = 17 (see table section 9.5)
Add 10,000 = 10,017 dec = 2721 hex

Interrogate : 02 03 2721 0001 B2
Where:-
02 = Destination Node
03 = Function 3
2721 = Register value (10,017 dec)
0001 = The number of registers to be read
B2 = Check sum

Reply : 02 03 02 XXXX KK
Where:-
02 = Node address
03 = Function code
02 = Byte count (the number of bytes to follow, 02 for a single register read)
XXXX = pulse count value (hex)
KK = Check sum

RTU Framing

In RTU mode, messages start with a silent interval of at least 3.5 character times. This is most easily implemented as a multiple of character times at the baud rate that is being used on the network (shown as T1-T2-T3-T4 in the figure below). The first field then transmitted is he device address.

The allowable characters transmitted for all fields are hexadecimal 0-9, A-F. Networked devices monitor the network bus continuously, including during the 'silent' intervals. When the first field (the address field) is received, each device decodes it o find out if it is the addressed device.

Following the last transmitted character, a similar interval of at least 3.5 character times marks the end of the message. A new message can begin after this interval.

The entire message frame must be transmitted as a continuous stream. If a silent interval of more than 1.5 character times occurs before completion of the frame, the receiving device flushes the incomplete message and assumes that the next byte will be the address field of a new message.

Similarly, if a new message begins earlier than 3.5 character times following a previous message, the receiving device will consider it a continuation of the previous message. This will set an error, as the value in the final CRC field will not be valid for the combined message. A typical message frame is shown below:

START	ADDRESS	FUNCTION	DATA	CRC CHECK	END
T1-T2-T3-T4	8-BITS	8-BITS	n x 8-BITS	16 BITS	T1-T2-T3-T4

9.5 Modbus / VersaNet2 Address Mapping.

The following table shows the mapping of the Modbus Register number to the card I/O address on VersaNet2. This is an extract from the complete table. Obviously the table is continuous from register 0 to 2048 with the corresponding card addresses running from 1 to 256.

Register '0' corresponds to the I/O on the main communications controller card with addresses D0.1 and A0.1.

There are 2 combination cards which have fixed addresses;
- the combination Output card is card number 30, which has 4 Digital and 2 Analogue outputs, addresses D30.1, D30.2, D30.3, D30.4 and A30.1, A30.2
- the combination Input card is card number 31, which has 4 Digital and 4 Analogue Inputs, addresses D31.1, D31.2, D31.3, D31.4 and A31.1, A31.2, A31.3, A31.4

The card numbers 1 to 29 can be assigned to any I/O cards in a Node. Numbers 32 to 256 can be used as Virtual outputs.

Table of Modbus / VersaNet Address Mapping

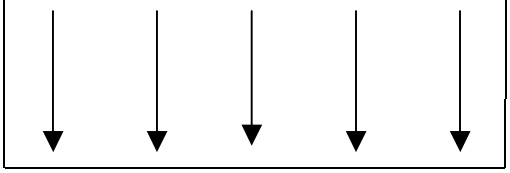
Register	Digital Inputs	Analog Inputs	Digital Outputs	Analog Outputs
0	D0.1	A0.1	D0.1	A0.1
1	D1.1	A1.1	D1.1	A1.1
2	D1.2	A1.2	D1.2	A1.2
3	D1.3	A1.3	D1.3	A1.3
4	D1.4	A1.4	D1.4	A1.4
5	D1.5	A1.5	D1.5	A1.5
6	D1.6	A1.6	D1.6	A1.6
7	D1.7	A1.7	D1.7	A1.7
8	D1.8	A1.8	D1.8	A1.8
9	D2.1	A2.1	D2.1	A2.1
10	D2.2	A2.2	D2.2	A2.2
11	D2.3	A2.3	D2.3	A2.3
12	D2.4	A2.4	D2.4	A2.4
13	D2.5	A2.5	D2.5	A2.5
14	D2.6	A2.6	D2.6	A2.6
15	D2.7	A2.7	D2.7	A2.7
16	D2.8	A2.8	D2.8	A2.8
17	D3.1	A3.1	D3.1	A3.1
18	D3.2	A3.2	D3.2	A3.2
19	D3.3	A3.3	D3.3	A3.3
20	D3.4	A3.4	D3.4	A3.4
21	D3.5	A3.5	D3.5	A3.5
22	D3.6	A3.6	D3.6	A3.6
23	D3.7	A3.7	D3.7	A3.7
24	D3.8	A3.8	D3.8	A3.8
25	D4.1	A4.1	D4.1	A4.1
26	D4.2	A4.2	D4.2	A4.2
27	D4.3	A4.3	D4.3	A4.3
28	D4.4	A4.4	D4.4	A4.4
29	D4.5	A4.5	D4.5	A4.5
30	D4.6	A4.6	D4.6	A4.6
31	D4.7	A4.7	D4.7	A4.7
32	D4.8	A4.8	D4.8	A4.8
33	D5.1	A5.1	D5.1	A5.1
34	D5.2	A5.2	D5.2	A5.2
35	D5.3	A5.3	D5.3	A5.3
36	D5.4	A5.4	D5.4	A5.4
37	D5.5	A5.5	D5.5	A5.5
38	D5.6	A5.6	D5.6	A5.6
39	D5.7	A5.7	D5.7	A5.7
40	D5.8	A5.8	D5.8	A5.8
41	D6.1	A6.1	D6.1	A6.1
42	D6.2	A6.2	D6.2	A6.2
43	D6.3	A6.3	D6.3	A6.3
44	D6.4	A6.4	D6.4	A6.4
45	D6.5	A6.5	D6.5	A6.5
46	D6.6	A6.6	D6.6	A6.6
47	D6.7	A6.7	D6.7	A6.7
48	D6.8	A6.8	D6.8	A6.8
49	D7.1	A7.1	D7.1	A7.1
50	D7.2	A7.2	D7.2	A7.2

51	D7.3	A7.3	D7.3	A7.3
52	D7.4	A7.4	D7.4	A7.4
53	D7.5	A7.5	D7.5	A7.5
54	D7.6	A7.6	D7.6	A7.6
55	D7.7	A7.7	D7.7	A7.7
56	D7.8	A7.8	D7.8	A7.8
57	D8.1	A8.1	D8.1	A8.1
58	D8.2	A8.2	D8.2	A8.2
59	D8.3	A8.3	D8.3	A8.3
60	D8.4	A8.4	D8.4	A8.4
61	D8.5	A8.5	D8.5	A8.5
62	D8.6	A8.6	D8.6	A8.6
63	D8.7	A8.7	D8.7	A8.7
64	D8.8	A8.8	D8.8	A8.8
65	D9.1	A9.1	D9.1	A9.1
66	D9.2	A9.2	D9.2	A9.2
67	D9.3	A9.3	D9.3	A9.3
68	D9.4	A9.4	D9.4	A9.4
69	D9.5	A9.5	D9.5	A9.5
70	D9.6	A9.6	D9.6	A9.6
71	D9.7	A9.7	D9.7	A9.7
72	D9.8	A9.8	D9.8	A9.8
73	D10.1	A10.1	D10.1	A10.1
74	D10.2	A10.2	D10.2	A10.2
75	D10.3	A10.3	D10.3	A10.3
76	D10.4	A10.4	D10.4	A10.4
77	D10.5	A10.5	D10.5	A10.5
78	D10.6	A10.6	D10.6	A10.6
79	D10.7	A10.7	D10.7	A10.7
80	D10.8	A10.8	D10.8	A10.8
81	D11.1	A11.1	D11.1	A11.1
82	D11.2	A11.2	D11.2	A11.2
83	D11.3	A11.3	D11.3	A11.3
84	D11.4	A11.4	D11.4	A11.4
85	D11.5	A11.5	D11.5	A11.5
86	D11.6	A11.6	D11.6	A11.6
87	D11.7	A11.7	D11.7	A11.7
88	D11.8	A11.8	D11.8	A11.8
89	D12.1	A12.1	D12.1	A12.1
90	D12.2	A12.2	D12.2	A12.2
91	D12.3	A12.3	D12.3	A12.3
92	D12.4	A12.4	D12.4	A12.4
93	D12.5	A12.5	D12.5	A12.5
94	D12.6	A12.6	D12.6	A12.6
95	D12.7	A12.7	D12.7	A12.7
96	D12.8	A12.8	D12.8	A12.8
97	D13.1	A13.1	D13.1	A13.1
98	D13.2	A13.2	D13.2	A13.2
99	D13.3	A13.3	D13.3	A13.3
100	D13.4	A13.4	D13.4	A13.4
101	D13.5	A13.5	D13.5	A13.5
102	D13.6	A13.6	D13.6	A13.6
103	D13.7	A13.7	D13.7	A13.7
104	D13.8	A13.8	D13.8	A13.8
105	D14.1	A14.1	D14.1	A14.1
106	D14.2	A14.2	D14.2	A14.2
107	D14.3	A14.3	D14.3	A14.3
108	D14.4	A14.4	D14.4	A14.4
109	D14.5	A14.5	D14.5	A14.5
110	D14.6	A14.6	D14.6	A14.6
111	D14.7	A14.7	D14.7	A14.7
112	D14.8	A14.8	D14.8	A14.8
113	D15.1	A15.1	D15.1	A15.1
114	D15.2	A15.2	D15.2	A15.2
115	D15.3	A15.3	D15.3	A15.3
116	D15.4	A15.4	D15.4	A15.4
117	D15.5	A15.5	D15.5	A15.5
118	D15.6	A15.6	D15.6	A15.6
119	D15.7	A15.7	D15.7	A15.7
120	D15.8	A15.8	D15.8	A15.8
121	D16.1	A16.1	D16.1	A16.1
122	D16.2	A16.2	D16.2	A16.2
123	D16.3	A16.3	D16.3	A16.3
124	D16.4	A16.4	D16.4	A16.4
125	D16.5	A16.5	D16.5	A16.5
126	D16.6	A16.6	D16.6	A16.6
127	D16.7	A16.7	D16.7	A16.7
128	D16.8	A16.8	D16.8	A16.8
129	D17.1	A17.1	D17.1	A17.1
130	D17.2	A17.2	D17.2	A17.2
131	D17.3	A17.3	D17.3	A17.3
132	D17.4	A17.4	D17.4	A17.4
133	D17.5	A17.5	D17.5	A17.5
134	D17.6	A17.6	D17.6	A17.6
135	D17.7	A17.7	D17.7	A17.7
136	D17.8	A17.8	D17.8	A17.8
137	D18.1	A18.1	D18.1	A18.1
138	D18.2	A18.2	D18.2	A18.2
139	D18.3	A18.3	D18.3	A18.3
140	D18.4	A18.4	D18.4	A18.4
141	D18.5	A18.5	D18.5	A18.5
142	D18.6	A18.6	D18.6	A18.6
143	D18.7	A18.7	D18.7	A18.7
144	D18.8	A18.8	D18.8	A18.8
145	D19.1	A19.1	D19.1	A19.1
146	D19.2	A19.2	D19.2	A19.2
147	D19.3	A19.3	D19.3	A19.3

148	D19.4	A19.4	D19.4	A19.4
149	D19.5	A19.5	D19.5	A19.5
150	D19.6	A19.6	D19.6	A19.6
151	D19.7	A19.7	D19.7	A19.7
152	D19.8	A19.8	D19.8	A19.8
153	D20.1	A20.1	D20.1	A20.1
154	D20.2	A20.2	D20.2	A20.2
155	D20.3	A20.3	D20.3	A20.3
156	D20.4	A20.4	D20.4	A20.4
157	D20.5	A20.5	D20.5	A20.5
158	D20.6	A20.6	D20.6	A20.6
159	D20.7	A20.7	D20.7	A20.7
160	D20.8	A20.8	D20.8	A20.8
161	D21.1	A21.1	D21.1	A21.1
162	D21.2	A21.2	D21.2	A21.2
163	D21.3	A21.3	D21.3	A21.3
164	D21.4	A21.4	D21.4	A21.4
165	D21.5	A21.5	D21.5	A21.5
166	D21.6	A21.6	D21.6	A21.6
167	D21.7	A21.7	D21.7	A21.7
168	D21.8	A21.8	D21.8	A21.8
169	D22.1	A22.1	D22.1	A22.1
170	D22.2	A22.2	D22.2	A22.2
171	D22.3	A22.3	D22.3	A22.3
172	D22.4	A22.4	D22.4	A22.4
173	D22.5	A22.5	D22.5	A22.5
174	D22.6	A22.6	D22.6	A22.6
175	D22.7	A22.7	D22.7	A22.7
176	D22.8	A22.8	D22.8	A22.8
177	D23.1	A23.1	D23.1	A23.1
178	D23.2	A23.2	D23.2	A23.2
179	D23.3	A23.3	D23.3	A23.3
180	D23.4	A23.4	D23.4	A23.4
181	D23.5	A23.5	D23.5	A23.5
182	D23.6	A23.6	D23.6	A23.6
183	D23.7	A23.7	D23.7	A23.7
184	D23.8	A23.8	D23.8	A23.8
185	D24.1	A24.1	D24.1	A24.1
186	D24.2	A24.2	D24.2	A24.2
187	D24.3	A24.3	D24.3	A24.3
188	D24.4	A24.4	D24.4	A24.4
189	D24.5	A24.5	D24.5	A24.5
190	D24.6	A24.6	D24.6	A24.6
191	D24.7	A24.7	D24.7	A24.7
192	D24.8	A24.8	D24.8	A24.8
193	D25.1	A25.1	D25.1	A25.1
194	D25.2	A25.2	D25.2	A25.2
195	D25.3	A25.3	D25.3	A25.3

196	D25.4	A25.4	D25.4	A25.4
197	D25.5	A25.5	D25.5	A25.5
198	D25.6	A25.6	D25.6	A25.6
199	D25.7	A25.7	D25.7	A25.7
200	D25.8	A25.8	D25.8	A25.8
201	D26.1	A26.1	D26.1	A26.1
202	D26.2	A26.2	D26.2	A26.2
203	D26.3	A26.3	D26.3	A26.3
204	D26.4	A26.4	D26.4	A26.4
205	D26.5	A26.5	D26.5	A26.5
206	D26.6	A26.6	D26.6	A26.6
207	D26.7	A26.7	D26.7	A26.7
208	D26.8	A26.8	D26.8	A26.8
209	D27.1	A27.1	D27.1	A27.1
210	D27.2	A27.2	D27.2	A27.2
211	D27.3	A27.3	D27.3	A27.3
212	D27.4	A27.4	D27.4	A27.4
213	D27.5	A27.5	D27.5	A27.5
214	D27.6	A27.6	D27.6	A27.6
215	D27.7	A27.7	D27.7	A27.7
216	D27.8	A27.8	D27.8	A27.8
217	D28.1	A28.1	D28.1	A28.1
218	D28.2	A28.2	D28.2	A28.2
219	D28.3	A28.3	D28.3	A28.3
220	D28.4	A28.4	D28.4	A28.4
221	D28.5	A28.5	D28.5	A28.5
222	D28.6	A28.6	D28.6	A28.6
223	D28.7	A28.7	D28.7	A28.7
224	D28.8	A28.8	D28.8	A28.8
225	D29.1	A29.1	D29.1	A29.1
226	D29.2	A29.2	D29.2	A29.2
227	D29.3	A29.3	D29.3	A29.3
228	D29.4	A29.4	D29.4	A29.4
229	D29.5	A29.5	D29.5	A29.5
230	D29.6	A29.6	D29.6	A29.6
231	D29.7	A29.7	D29.7	A29.7
232	D29.8	A29.8	D29.8	A29.8
233			D30.1	A30.1
234			D30.2	A30.2
235			D30.3	
236			D30.4	
237				
238				
239				
240				
241	D31.1	A31.1		
242	D31.2	A31.2		
243	D31.3	A31.3		

244	D31.4	A31.4		
245				
246				
247				
248				
249	D32.1	A32.1	D32.1	A32.1
250	D32.2	A32.2	D32.2	A32.2
251	D32.3	A32.3	D32.3	A32.3
252	D32.4	A32.4	D32.4	A32.4
253	D32.5	A32.5	D32.5	A32.5
254	D32.6	A32.6	D32.6	A32.6
255	D32.7	A32.7	D32.7	A32.7
256	D32.8	A32.8	D32.8	A32.8
257	D33.1	A33.1	D33.1	A33.1
258	D33.2	A33.2	D33.2	A33.2
259	D33.3	A33.3	D33.3	A33.3
260	D33.4	A33.4	D33.4	A33.4
261	D33.5	A33.5	D33.5	A33.5
262	D33.6	A33.6	D33.6	A33.6
263	D33.7	A33.7	D33.7	A33.7
264	D33.8	A33.8	D33.8	A33.8
265	D34.1	A34.1	D34.1	A34.1
266	D34.2	A34.2	D34.2	A34.2
267	D34.3	A34.3	D34.3	A34.3
268	D34.4	A34.4	D34.4	A34.4
269	D34.5	A34.5	D34.5	A34.5
270	D34.6	A34.6	D34.6	A34.6
271	D34.7	A34.7	D34.7	A34.7
272	D34.8	A34.8	D34.7	A34.8



2017	D253.1	A253.1	D253.1	A253.1
2018	D253.2	A253.2	D253.2	A253.2
2019	D253.3	A253.3	D253.3	A253.3
2020	D253.4	A253.4	D253.4	A253.4
2021	D253.5	A253.5	D253.5	A253.5
2022	D253.6	A253.6	D253.6	A253.6
2023	D253.7	A253.7	D253.7	A253.7
2024	D253.8	A253.8	D253.8	A253.8
2025	D254.1	A254.1	D254.1	A254.1
2026	D254.2	A254.2	D254.2	A254.2
2027	D254.3	A254.3	D254.3	A254.3
2028	D254.4	A254.4	D254.4	A254.4
2029	D254.5	A254.5	D254.5	A254.5
2030	D254.6	A254.6	D254.6	A254.6
2031	D254.7	A254.7	D254.7	A254.7
2032	D254.8	A254.8	D254.8	A254.8
2033	D255.1	A255.1	D255.1	A255.1
2034	D255.2	A255.2	D255.2	A255.2
2035	D255.3	A255.3	D255.3	A255.3
2036	D255.4	A255.4	D255.4	A255.4
2037	D255.5	A255.5	D255.5	A255.5
2038	D255.6	A255.6	D255.6	A255.6
2039	D255.7	A255.7	D255.7	A255.7
2040	D255.8	A255.8	D255.8	A255.8
2041	D256.1	A256.1	D256.1	A256.1
2042	D256.2	A256.2	D256.2	A256.2
2043	D256.3	A256.3	D256.3	A256.3
2044	D256.4	A256.4	D256.4	A256.4
2045	D256.5	A256.5	D256.5	A256.5
2046	D256.6	A256.6	D256.6	A256.6
2047	D256.7	A256.7	D256.7	A256.7
2048	D256.8	A256.8	D256.8	A256.8